Petroleum Processing

Petroleum Refining • Petrochemical Manufacturing • Gas Liquids Recovery SEPTEMBER, 1956

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The **TOTAL PICTURE** p.95

PETROCHEMICALS 1956 REPORT

Up-Dater on **ETHYLENE** p.107

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NEW THIS MONTH—how to get more patent information . . p.163

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PRICE 35 CENTS

PETROLEOS MEXICANOS

Gas Processing Plant

REYNOSA, MEXICO

Below the Rio Grande, near Reynosa, in Tamaulipas, Mexico, Petroleos Mexicanos has recently completed this major gas processing project designed to process 300 million cubic feet of natural gas daily gathered from numerous fields within an area of about 400 square miles. About 8,000 barrels per day of fractionated products, including propane, butanes, motor fuel, naphtha and kerosene will be produced.

Engineering design and procurement of equipment was entrusted to Hudson, and the satisfaction of our client is attested by a current contract for a similar but even larger project for Petroleos Mexicanos on the Isthmus of Tehuantepec.

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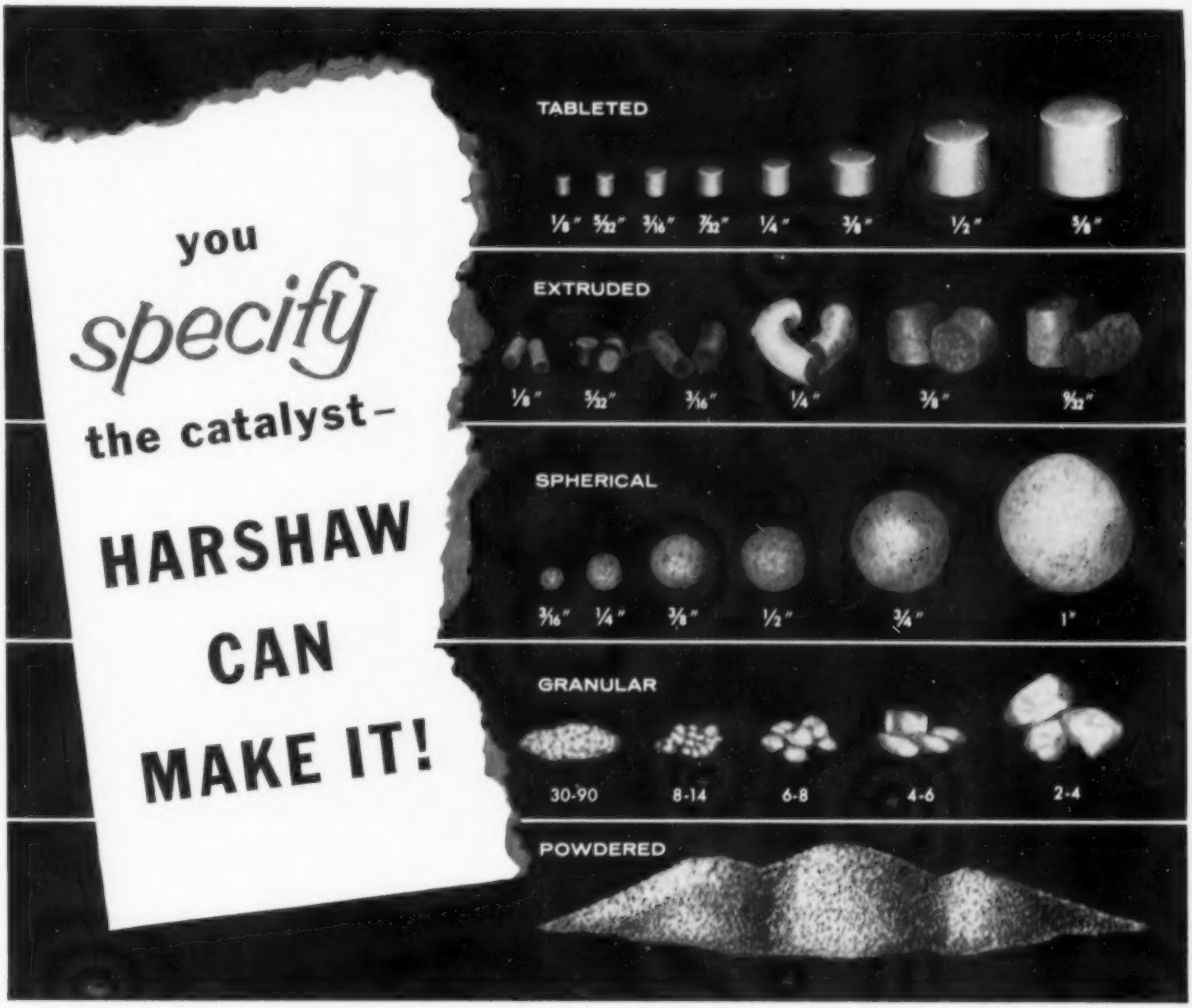

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Reader's Guide

What's New in Petroleum

I II III 1 2 3 4 5

PETROCHEMICALS—1956 REPORT

A special 46-page section in six parts

1 The Industry Itself and the Immediate Outlook – Total 1956 production is expected to hit 34-billion lbs, about 9.7% over 1955 figures, not as large an increase as a year ago, but still a hefty and healthy growth. **p. 95**

2 Synthetic Rubber – Why is it one of the "hottest" petrochemical products today? Who is doing what in this field? What are the important types of synthetic rubber? And why are they important? A penetrating study and analysis, by B. H. Weil. **p. 98**

3 Versatile Ethylene – one of most significant petrochemical raw materials today. Here is a thorough-going up-dater on the detailed study of the ethylene petrochemicals first published five years ago in this magazine, and by the same authors, Wayne E. Kuhn and John W. Hutcheson. **p. 107**

4 Other Major Petrochemicals – Fast-reading, supply-demand outlooks on eight other materials, prepared by authorities in their fields. Petrochemicals discussed include aromatics, butadiene, carbon black, synthetic detergents, formaldehyde, nitrogen products, plastics, and sulfur **p. 110**

5 Fifth Annual Plant Survey of the petrochemical industry in the United States and Canada. Over $1-billion is being invested currently in new facilities. There are 197 companies and 362 plants. For complete details, turn to . . . **p. 117**

6 New This Year — a Petrochemical Glossary. Here is a list of products, keyed to the plants in this year's directory. PLUS a brief description of each material. The description includes chemical composition, physical properties, chemical derivation, and principal end-uses. **p. 133**

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ABP ABC

Member of Associated Business Publications and Audit Bureau of Circulations

Petroleum Processing is published monthly by McGraw-Hill Publishing Co., Inc., James H. McGraw (1860-1948) founder.

Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 West 42nd St., New York 36, N. Y. Publication Office: 871 N. Franklin St., Chicago 10, Ill. Donald C. McGraw, President; Paul Montgomery, Executive Vice President; Joseph A. Gerardi, Executive Vice-President and Treasurer; John J. Cooke, Secretary; Hugh J. Kelly, Executive Vice-President; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; J. E. Blackburn, Jr., Vice-President and Circulation Director.

Subscriptions: Address correspondence to Petroleum Processing, Subscription Service 330 West 42nd St., New York 36, N. Y. Subscription rates: domestic single copies, 35¢, U. S. and possessions, Canada, and all other countries, $2 per year, $3 for two years, $4 for three years. Orders must indicate company and position.

Published prior to Sept. 1946 as the Technical Section of National Petroleum News, devoted to Refinery Management and Petroleum Chemical Technology, and including International Petroleum Technology.

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Processing for September, 1956

I II III 1 2 3 4 5

Technical Tips on Coking

The latest information available for you as a process man, from today's plant operators. The fourth in our 1956 series of articles based on the popular question-and-answer session at the Western Petroleum Refiners' Assn. fall meeting. **p. 141**

I III 2 3 5

Predict Storage Stabilities

Use this newly developed rapid test procedure for checking middle distillates. It's an analysis worked out by Esso Research & Engineering Co., and completely described in this issue by W. A. Konrad, N. L. Shipley, and T. S. Tutwiler. **p. 145**

I 1 3

Revamp Without a Shutdown?

Yes, that's what Texas City Refining, Inc., did when they expanded the capacity of their alkylation unit recently. Here's an up-to-the-minute report telling how they did it. In this month's M&C feature article by C. F. Tennison. **p. 150**

I 3 4

Solly's New "What-Is-It?"

The Old Man had to know exactly why Solly had some guy doing nothing all day but watch a safety valve. And, the Old Man had a few fast answers for Solly's dilemma. Read all about it in the latest episode in the life of the Bull Pen. **p. 155**

I II III 1 2 3 4 5

Tricks at the "Board"

. . . you can use to advantage for increasing drafting production and efficiency. The third in a series of four articles on a much neglected subject – the improvement of drawing room procedures. By Robert Kern. **p. 156**

I II III 2

NEW THIS MONTH

More Help from Patents

Don't miss out on industry's plans today for possible use tomorrow because patent searches are too tough to handle. Your regular Patents department has been revamped to help you. Turn to **p. 163**

I II III 1 2 3 4 5

And What's Ahead

Watch Those Future Issues

They'll continue bringing you more information-packed pages. Don't miss any of them.

Articles coming up soon will cover these topics:

- New ideas for controlling and reducing your operating costs
- Fundamental information on the chemistry of inhibitor sweetening
- How to beat the problem of handling solid materials instead of liquids or gases
- Tips on working with insulation for low temperature applications
- Another big special report on a process of major significance today

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Continue "Readers' Guide" on p. 165

HOW TO USE IT:

Your new "Reader's Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest; Roman Numerals indicate industries; Arabic Numerals, fields of activity. Second, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you. —The Editors

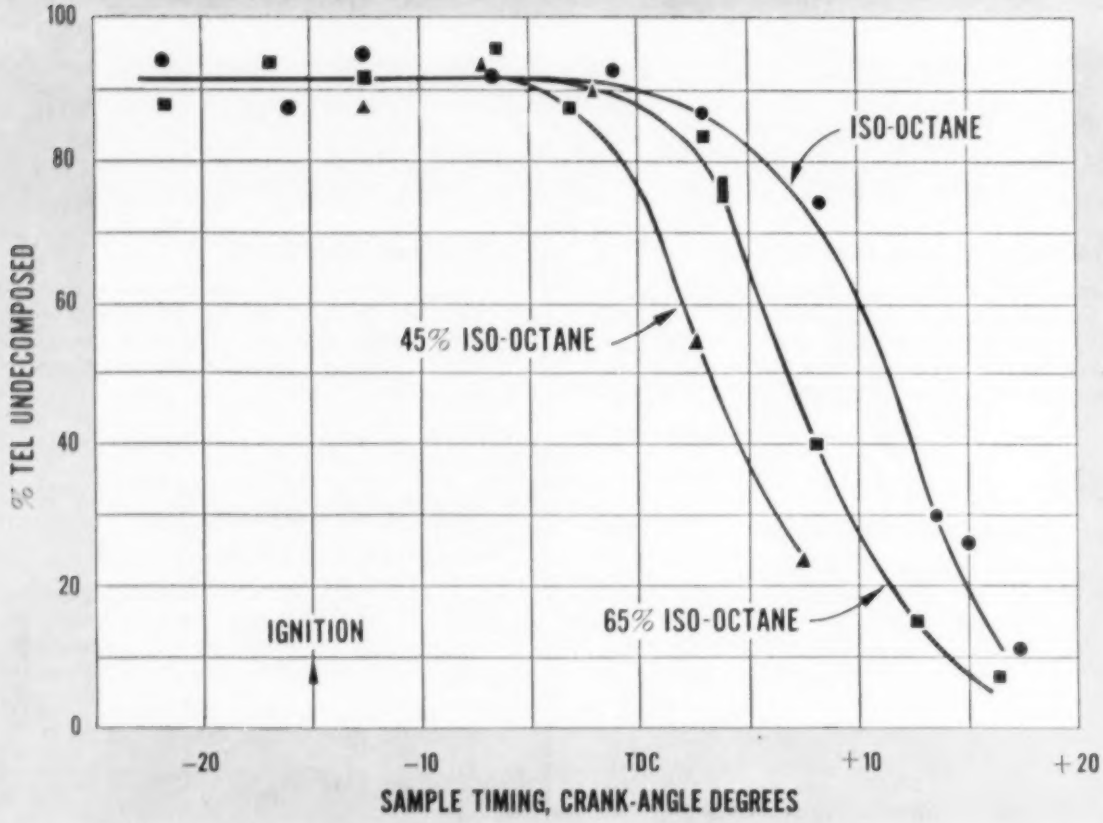


Fig. 1. TEL decomposition in fired engine. Fuels: mixtures of iso-octane and n-heptane containing 6 ml TEL per gallon.

New research on antiknock action

by ***ELLIS B. RIFKIN***
Ethyl Corporation, Detroit, Mich.

Although tetraethyllead is widely used as an antiknock agent, some fundamentals of its action are still not completely understood. Since a full understanding of the mechanism of its action could presumably lead to increased effectiveness of utilization—the Ethyl Corporation conducts a continuing basic research program on antiknocks.

Many theories concerning the mechanism by which tetraethyllead acts as an antiknock in the internal combustion engine involve either the process by which tetraethyllead decomposes or the products resulting from such decomposition.

This report describes the studies of variables affecting the decomposition of tetraethyllead both in fired engines and in motored engines.

In a first series of experiments, a spark-ignited, fixed-compression ratio, L-head engine was employed. This engine was equipped with a sampling valve of special design which permits repetitive extraction of small samples from the end-gas region of the combustion chamber.

Mixtures of iso-octane and normal heptane were used as fuels, and end-gas samples were taken at 5° intervals from 25° before top center to 20° after top center. The results of these studies are indicated in Figure 1 which shows:

1. That essentially all the tetraethyllead is decomposed before the mixture is consumed by the flame front.

2. That the rate of tetraethyllead decomposition is markedly affected by fuel composition.

In order to resolve this effect of fuel composition more completely, it was decided to conduct a second series of experiments—this time in a motored engine, to permit measurement of temperatures. A single-cylinder engine was again used, but in this series of experiments, the engine was of the variable-compression ratio type to permit variation of temperature and pressure of the fuel-air mixture over as wide a range as possible.

Mixtures of iso-octane and normal heptane as well as di-isobutylene were the fuels tested. Figure 2 illustrates the effect of fuel composition on tet-

 (To obtain more data on advertised products see page 208)

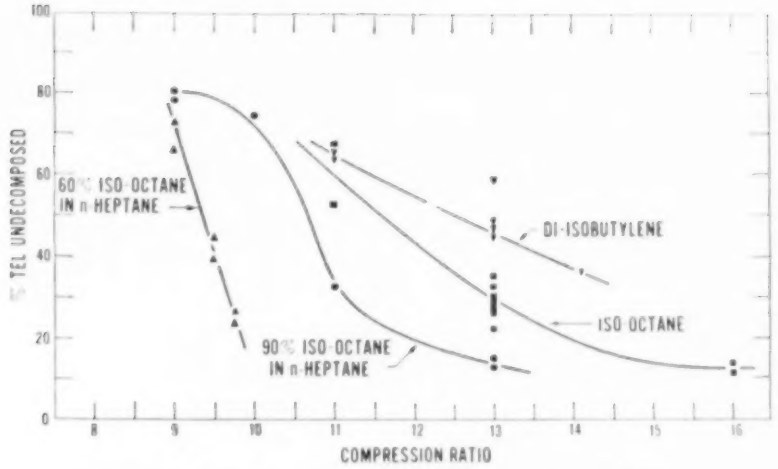


Fig. 2. Effect of fuel on TEL decomposition in a motored engine.

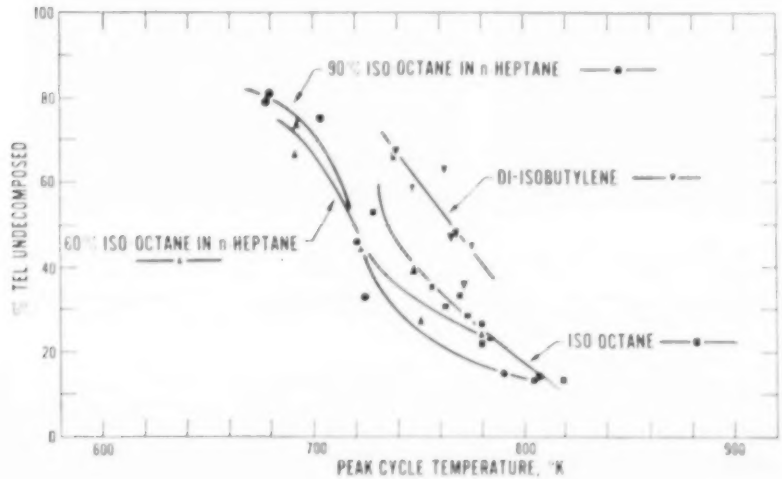
raethyllead decomposition in the motored engine—somewhat comparable data to that shown in Figure 1 for the fired-engine studies.

Again, an apparent correlation was obtained between fuel composition and rate of tetraethyllead decomposition—with the more rapid rates being associated with fuels of higher octane number.

To gain still greater insight into this relationship, technicians calculated peak cycle temperatures and the tetraethyllead decomposition data were examined against this variable. The results of this work are shown in Figure 3. It can be seen immediately that most of the variation due to fuel composition has been eliminated. This leads to the conclusion that temperature may be the one basic variable governing the decomposition of tetraethyllead—and that fuel composition has only an indirect influence so far as it affects the peak temperature of the charge in the cylinder. A mathematical analysis taking into account the variation in temperature of the charge throughout the cycle and comparison of those data with tetraethyllead decomposition data confirm this conclusion.

This account of one typical research project in the Ethyl Laboratories is designed to give you in the petroleum industry a glimpse into the vast body of continuing research being carried out to guarantee the maximum effectiveness of "Ethyl" Antiknock Compound.

Fig. 3. TEL decomposition in four fuels related to peak cycle temperature.



What Ethyl Research offers you

Ethyl Research is in the unusual position of being able to serve both the petroleum and automotive industries.

In that capacity, we have contributed much in the field of fundamental as well as applied research. Today at our laboratories in Detroit we are conducting studies on the nature of combustion . . . the cause of preignition . . . and the mechanism of deposit accumulation.

Searching for answers to these "basic" problems has led us to develop many new instruments and new techniques. The information which we have developed from our research efforts is being constantly circulated throughout both the automotive and petroleum industries to help the different companies with their research.

If you desire any information concerning fuel-engine problems, just contact your Ethyl Laboratory Technical Representative.

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JOHN WIGGINS' ANSWERS TO 8 QUESTIONS CAN HELP YOU SELECT A BETTER FLOATING ROOF SEAL

Are all floating roof seals the same? What about safety? Conservation? We asked John Wiggins, inventor of the floating roof and noted conservation authority, to answer questions most commonly asked about the new Wiggins Safety Seal.

1—**Q.** In the new Wiggins Safety Seal does any of the mechanism contact the liquid?

A. No. All metal working parts are out of the liquid away from corrosive vapors.

2—**Q.** Does the new "Weather Hood" provide longer fabric life?

A. Yes—the fabric is protected from the sun and other elements—lower temperature under the hood provides added conservation.

3—**Q.** In old style seals, rust and scale accumulate and shorten seal life. Does this happen with this seal?

A. The "Weather Hood" prevents rust and scale from depositing in the "seal loop"—thereby increasing seal life.

4—**Q.** Does the Wiggins Safety Seal prevent rim fires?

A. Yes—design of the seal virtually eliminates critical vapor spaces where air and vapor collect to form explosive mixtures. When exploded through controlled tests, the fabric was able to expand enough to contain the explosion without tearing.

5—**Q.** Is this seal safe for the storage of low vapor-pressure, low flash-point liquids such as jet fuels?

A. Yes, the design of the Wiggins Safety Seal reduces the danger area to a minimum so that it can be used in the storage of jet fuels with complete confidence.

6—**Q.** How does the Wiggins Safety Seal guarantee maximum protection against evaporation loss?

A. Air-vapor volume of the Safety Seal is less than 10% of the present volume for floating roof seals. This would eliminate most losses. In addition, the air-vapor space is shielded by a "Weather Hood". This area—the area that breathes—reduces losses to a minimum.

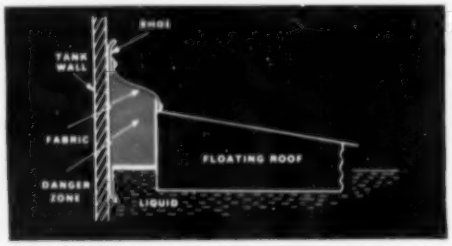
7—**Q.** Will the Wiggins Safety Seal save me money?

A. Yes—by eliminating losses due to thermal breathing, preventing rim fires, use of new longer-lived fabric, protecting the mechanism from liquid and corrosive vapors and permitting much longer periods of "in-service" operation.

8—**Q.** Why have you put so much emphasis on the seal?

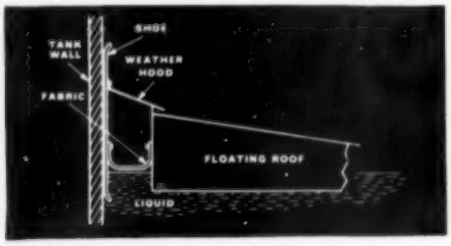
A. A floating roof is only as safe as its seal. With the new Wiggins Safety Seal, Wiggins floating roofs are in a class by themselves. Since General American makes all types of floating roofs, you can have the Wiggins Safety Seal on the roof that best meets your needs—whether it be the Wiggins Hidek*-Lodek* or Doubledek*.

*Patented



OLD

With the old type seal, the fabric is exposed to the sun's rays and explosive vapor collects in the large space between the liquid and the fabric; the mechanism is submerged in the liquid and exposed to corrosive vapors.



NEW

With the new Wiggins Safety Seal, vapor space under the circumferential fabric is reduced to a minimum. Ends spark fire hazards. Fabric is protected from the sun. Mechanism is out of liquid and corrosive vapor space.

To see why Wiggins Floating Roofs pay for themselves, write or call your General American sales engineer.

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Publisher's Page

Who's Interested in Numbers, Anyway?

REMEMBER Carl Harper? He's that engineer-friend of mine with a major oil company to whom I introduced you on this page last January. Harper isn't his real name, however. Carl's a friendly sort of guy, but he also tends to be critical. Maybe that's why I like to talk with him—because he doesn't hesitate to knock my ears down and tell me what he thinks is wrong with magazines in general and this one in particular.

One day last spring I called on Carl—and after a few friendly formalities he let go. "Why in thunder don't you guys wake up? Here we have in this country one of the richest pipelines of information—our patents. They'll tell the bright fellow who studies and evaluates them some of the technical advances that are coming along years before they're announced. And what do you blockhead editors do? You run lists of patent numbers that it takes a bulldozer to plow through."

So we woke up. We took a new look at patents. We began figuring out different ways in which we could give you a listing of all the current patents of particular interest. We experimented with ways of writing them, of arranging them, of setting them in type.

And we've come up with a "new" patent listing that I think you will find both easier and quicker to use. It arranges patents entirely by subject, from start to finish—and subject matter is what you're looking for, not patent numbers.

Take a look at the new "Patents" department this month, starting on page 163. Carl's already seen some advance proofs—and approves.

William F. Bland

—Editor

P.S.—We almost let it go unannounced—but at the last minute we decided we just couldn't. This is the 10th anniversary of PETROLEUM PROCESSING. Volume 1, Number 1 in September, 1946, was all of 80 pages (this issue is 246). The front cover showed a Houdry Catalytic Cracking case being inspected at Sun's Toledo, Ohio, refinery. Lead story in the issue was about a pump maintenance program developed by Standard Oil Co. of New Jersey (now Esso Standard Oil Co.). The editorials urged prompt disposal of the wartime "avgas" plants, and congratulated the Petroleum Division of the American Chemical Society on its 25th anniversary. We had four editors on our staff then—and three are still with us: Virg Guthrie, Bill Uhl, and I.

—W.F.B.

Other McGraw-Hill Petroleum Publications

National Petroleum News
The monthly magazine of oil marketing—news, prices, transportation, storage, merchandising

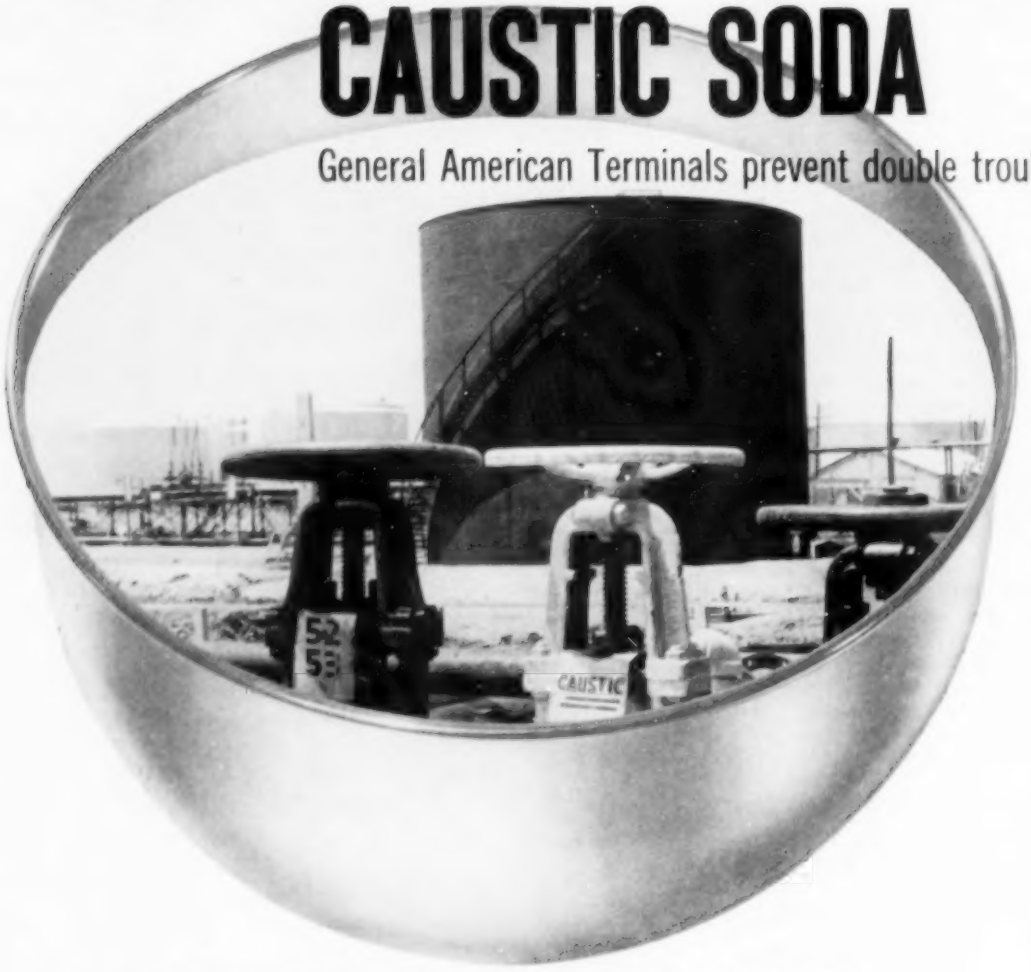
Platt's Oilgram News Service
A daily independent oil-news reporting service issued from New York, Chicago, Houston

Platt's Oilgram Price Service
A daily independent oil-price reporting service issued from New York, Chicago, Houston

Petroleum Week
The industry-wide magazine—covering production, processing, transportation, marketing

"WARMING KETTLES" FOR CAUSTIC SODA

General American Terminals prevent double trouble!



Six terminals at 5 key-market locations with over 13,000,000 barrel capacity: PORT OF NEW YORK (Carteret, N. J.) • PORT OF NEW ORLEANS (Good Hope, La.) • CHICAGO, ILLINOIS (Bedford Park) • PORT OF HOUSTON (Galena Park and Pasadena, Texas) • CORPUS CHRISTI, TEXAS

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General American may be able to help you solve your storage problems. Leased facilities at any of the six "key market" General American terminals give you the privacy, safety, service and flexibility of your own terminals—*without capital investment on your part.*

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What's Happening

. . . **Petrochemical boom continues,** according to results of PETROLEUM PROCESSING Mid-Year Survey (see pp. 95-140, this issue), though the 1956 increase is appreciably lower than the 1955 increase (9.4% versus 21%). Total 1956 production of petrochemicals may reach 35-billion lb. Other highlights of the petrochemical industry are:

- Synthetic rubber demand levels off.
- Plastics boom paces petrochemicals, with plastics manufacturers eyeing home construction market.
- 1957 petrochemical production increase should exceed the 1956-over-1955 increase.

in Refining

. . . **Standard Oil Co. (Ind.)** will build a lube oil dewaxing plant at its Whiting, Ind. refinery. Using a new urea process to produce 10-million gal/yr of low pour point oils, it will eliminate need for special wax-free crudes. Operation is scheduled for October.

. . . **The Texas Co.** made first announcement of a 25,000 b/d furfural unit for treatment of virgin gas oil cracking stock recently placed onstream at the Los Angeles refinery. Said to be first such unit in world, it gives about 94% yield of raffinate for fluid cat cracker.

. . . **Premier Oil Refining Co.** (recently purchased by City Products Corp., see PETROLEUM PROCESSING, Aug., 1956, p. 10) will spend $1.25-million to modernize its 4500 b/d refinery at Longview, Tex. Largest sum will be for Platformer and Unifiner, with completion set for early 1957.

. . . **Delhi-Taylor Oil Corp.** will build a 14,000 b/sd Unifiner-Platformer unit, and a 4500 b/d Udex unit at its Corpus Christi, Tex. refinery. Completion is due early 1957.

. . . **Salt Lake Refining** (Standard of Calif.) will build a 6000 b/d platinum-catalyst reformer at its Salt Lake City refinery. Completion due Sept. 1957.

. . . **Champlin Refining Co.,** Fort Worth, Tex., has bought an ALWAC III-E digital electronic computer to help increase refinery operating efficiency.

. . . **Gulf Oil Corp.** plans a 26,000 b/d Platformer, the second such unit at its Port Arthur, Tex. refinery, with completion scheduled early 1958.

. . . **Universal Oil Products Co.** will spend over $1-million dollars to expand development and manufacturing facilities in the Chicago area and at the Shreveport, La. manufacturing plant.

. . . **American Oil Co.** will build its second 21,000 b/d Ultraformer at Texas City, together with a 21,000 b/d Sovafiner feed preparation unit. Completion is scheduled before the end of 1957.

. . . **The Air Pollution Control District for** Los Angeles has put the smog finger on automobile exhausts and backyard incinerators, to the possible relief of area refiners.

. . . **Sioux Oil Co.'s** light-ends recovery unit at its 4000 b/d refinery, Newcastle, Wyo. (see PETROLEUM PROCESSING, July, 1956, p. 9) will cost $85,000, with completion mid-Sept.

. . . **Alkylates for the Military** are needed in the Pacific Northwest according to Armed Services Petroleum Purchasing Agency. They want 2000 b/d more.

. . . **Westland Oil Co.** plans to increase Capacity of its Williston, N. D. refinery from present 1500 b/d to 2000 b/d. A thermal cracker will be added, with cat reforming considered for future.

. . . **Other new construction projects,** indicated by recent fast tax write-off approvals are:

- Standard Oil Co. (Ohio), $513,000 for oil refining facilities, Lima, Ohio.
- Phillips Petroleum Co., $2,452,225 for natural gas liquids, Garvan City, Okla.
- Tidewater Oil Co., $16,900,000 for 22,500 b/d catalytic reformer and steam generation plant, Avon, Calif.

in Gas Liquids Recovery

. . . **Gasoline extraction plant** will be built by the Fluor Corp. at Eunice, La., for Union Oil & Gas Corp. of La. and Texas Gas Exploration Corp. The plant will process 300 million SCF/day of natural gas for natural gasoline, butane and propane. Completion is due June 1957.

. . . **Sunray Mid-Continent Oil Co.** has its new cycling plant onstream at Northwest Branch, La. Capacity is 690,000 MCF of natural gas/month, producing 65,500 bbl/month of gas liquids.

in Petrochemicals

. . . **World's largest butadiene plant,** at Port Neches, Tex., jointly owned by Texas-U. S. Chemical and Goodrich-Gulf Chemicals, Inc., will have a $20-million to $25-million expansion to increase capacity

50% (to 300,000 t/yr). Work has started—completion is set for fall of 1958.

. . . **Du Pont** plans to convert its 650 t/day ammonia plant at Belle, W. Va. from coal to natural gas. Reports are that the Texaco synthesis-gas process will be used.

. . . **Wyandotte Chemical Co.'s** $8-million ethylene oxide plant (see PETROLEUM PROCESSING, Aug., 1956, p. 9) will be located at Geismar, La. The 60-million lb/yr plant will use the new Shell Development Co. process, with completion scheduled late 1957.

. . . **Imperial Chemical Industries, Ltd.,** of England, will team with Hercules Powder Co. to build a $11-million methyl methacrylate plant near Louisiana, Mo., using natural gas and ammonia raw materials.

. . . **Canadian Oil Companies, Ltd.** will start fall construction on a $3-million petrochemical unit at its Sarnia, Ontario, refinery (see PETROLEUM PROCESSING, July, 1956, p. 10). Plant includes 3650 b/d Udex unit and 4400 b/d Platformer scheduled for completion in summer of 1957.

. . . **General Tire & Rubber Co.** has started work on 50% expansion of its Ashtabula, O., vinyl resin plant. Present capacity is 25-million lb/yr.

. . . **Firestone Tire & Rubber Co.** will expand synthetic rubber capacity 27% (to 190,000 long t/yr) at its Lake Charles, La. plant. Completion due Dec. 1956.

. . . **Shell Chemical Co.** plans a 5000 t/yr diammonium phosphate production, in facilities built for ammonium sulfate, at Pittsburgh, Calif. Using a process similar to the one developed by TVA, production is scheduled for this year.

. . . **Humble Oil Co.** plans $27-million cat cracking unit (55,000 b/d) at Baytown, Tex. refinery, to make components for butyl rubber and butadiene.

. . . **British American Oil Co.** has started construction of plant to produce 225 long t/day sulfur from natural gas. Near Pincher Creek, Alta., the plant is scheduled for production Oct. 1956.

. . . **Southwest Agricultural Chemical Co.** will spend $5-million for a 100 t/day ammonia plant at Chandler, Ariz.

. . . **Cary Chemicals, Inc.** will build a 12-million lb/yr polyvinyl chloride plant at Flemington, N. J. Scientific Design Co. will design and build the plant, with onstream scheduled early 1957.

. . . **Shell Chemical Corp.** will expand copolymer facilities at Torrance, Calif. to give its synthetic rubber plant an over-all capacity of 110,000 long t/yr. Cost is "several millions."

. . . **The Texas Co.'s** 180 t/day ammonia plant at Lockport, Ill. (see PETROLEUM PROCESSING, Aug., 1956, p. 10) will use the Casale process, and will be built by Foster Wheeler Corp.

. . . **Standard Oil Co. (Calif.)** will build a benzoictoluic acid plant at its Richmond refinery. Production will be "several million lb/yr" with production scheduled to start late 1956.

. . . **Pan-Am Southern Corp.** is building a 250 b/cd polybutylene unit at its Destrehan, La. plant.

. . . **Shell Oil Co. of Canada, Ltd.'s** new alkylation plant for dodecyl benzene and gasoline blending components (see PETROLEUM PROCESSING, Aug., 1956, p. 10) will cost $3-million.

in Transition

. . . **Vulcan-Cincinnati, Inc.** is the new name for Vulcan Copper & Supply Co. of Cincinnati, O. The company will continue to serve the chemical and petrochemical industries.

. . . **Ashland Oil & Refining Co.** has bought the assets of R. J. Brown & Co., Kentucky chemical and solvent producer.

. . . **The Texas Co.** has reached agreement with British government on terms for its proposed purchase of Trinidad Oil Co. Sale will be concluded on Sept. 3.

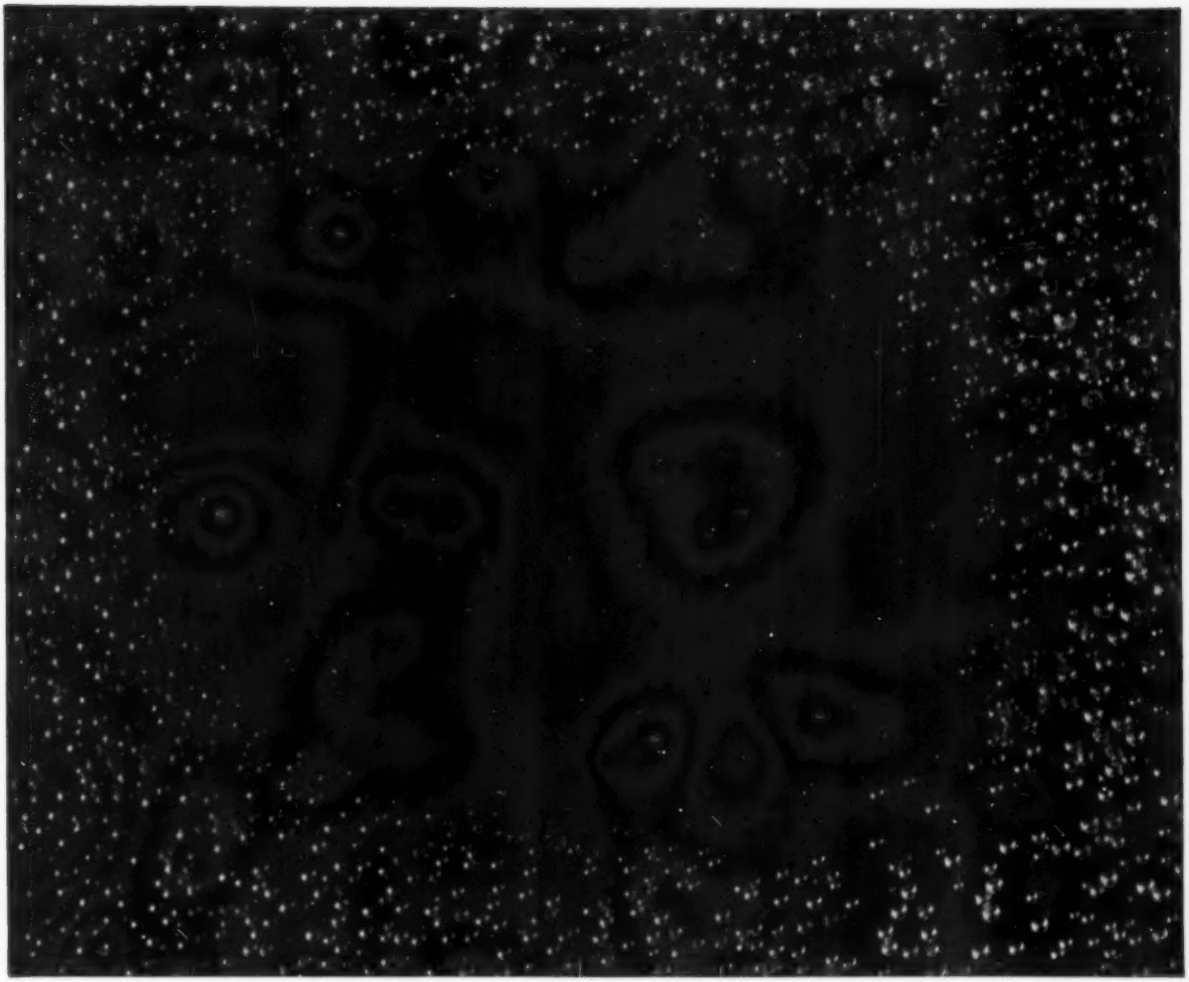
. . . **Wilcox Oil Co.** shut down its 5500 b/d, Bristow, Okla., refinery. The constant fight to keep in the high octane race was blamed. Wilcox will continue marketing, using products from D-X Sunray Oil Co.

. . . **Shamrock Oil & Gas Co.'s** Sunray, Texas, refinery will be back onstream shortly, following shutdown caused by recent pentane tank fire that killed 19 men. See photo p. 162.

. . . **Kerr-McGee Oil Industries** has joined Pacific Uranium Mines Co. and Anderson Development Corp. to form Kermac Nuclear Fuels Corp. They will mine and mill uranium ore in Ambrosia Lake area of N. M.

. . . **Sinclair Oil Corp.** will buy assets from Southern Production Co., Inc. of Ft. Worth, Texas. To include gas and crude properties, it also includes 40% ownership in new 25,000 b/d St Paul, Minn. refinery.

. . . **The Texas Co.** also has entered the uranium field with the purchase of "Happy Jack" uranium mine,



An Inside-Out View

CORROSION INHIBITOR AT WORK

Here's an external view of what takes place internally in refinery equipment. This photograph shows a piece of mild steel. The center has been treated with Polyrad. The entire piece of steel then was immersed in an acidic environment. The tiny bubbles of hydrogen show the beginning of corrosion. But the center portion remains a safety island—thanks to Polyrad.

This photographic impression bears out what most refinery operators already know—that Polyrad is an effective inhibitor. It will economically reduce corrosive damage with an average treatment of about 1 quart of Polyrad per 1,000 barrels of fluid.

Polyrad's powerful detergent action also serves to loosen organic and inorganic deposits, allowing them to be removed in the fluid stream.

All around the refinery, Polyrad can help maintain throughput, increase heat transfer, reduce metal loss, and cut down-time for maintenance. A Hercules technical representative will be glad to explain how Polyrad can be used to combat your specific corrosion problem.

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HERCULES POWDER COMPANY
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FILMING AMINE INHIBITOR

M954

Utah, through jointly-owned Texas Zinc Minerals Corp. The price was over $15-million.

. . . . **Continental Oil Co.** will dismantle its 4500 b/d Glenrock, Wyo. refinery that was closed in Feb. as uneconomical.

in Foreign Operations

. . . **Britain and Europe:**

Buna-Werke-Huels Co. plans to go onstream with a new synthetic Buna rubber plant by summer-1958. The 45,000 t/yr plant will make a product closely resembling natural rubber.

Dutch State Coal Mines (Amsterdam, Holland) will "considerably expand" its production of caprolactam and nylon also make polyethylene on large scale.

Farbenfabriken Bayer AG will build a cracking plant at its Dormagen plant to produce gaseous olefins, mainly ethylene, as part of $143-million capital spending program for 1956-1958.

British Petroleum Co., Ltd. plans 8000 b/d Hydrofiner and 7000 b/d catalytic reformer at the Antwerp, Belgium, refinery, owned jointly with Petrofina.

Esso Petroleum Co., Ltd. plans $36.4-million expansion at its Fawley, England, refinery (in addition to $25.2-million announced in April). Refinery capacity will be upped by 60,000 b/d, to 210,000 b/d.

West Germany refined 38,496,600 bbl of oil during the first half of 1956, an increase of 5,703,200 over the first half of 1955.

. . . **Latin America**

Fertilizantes de México S. A. will build an $11-million fertilizer plant to produce 100 t/day ammonia, 80% used for ammonium nitrate. Completion is scheduled for mid-1958.

. . . **Venezuela's national petrochemical industry** will get a push with the new 3000 b/d refinery planned for completion within a year. Location will be at Morón, on the Caribbean coast.

. . . **the East**

Jordon's government will offer all Arab countries a chance to buy shares in the $11.4-million, 6000 b/d refinery to be built at El-Zarkaa.

Shell Chemical Pty., Ltd., & United Carbon Co. plan to build a carbon black plant at Geelong, Victoria, Australia, to cost about $5.6-million.

Syrian government has narrowed bids on its proposed $15.4-million refinery to one from Procon Ltd. and one from Czechoslovakia.

New Ceylon government has killed plans for joint $35-million refinery by Shell, British Petroleum, Standard-Vacuum and Cal-Tex as "too monopolistic."

Stone & Webster Engrg. Corp. will build three new petrochemical units in Japan. Mitsui Petrochemical Industries at Iwakuni City has contracted for the Orient's first phenol plant. Sumitomo Chemical Co. plans an ethylene plant, and Nippon Petrochemicals, Ltd. has contracted for isopropyl alcohol and acetone units.

in Markets and Prices

. . . Local adjustments in crude oil prices continued in August, with large buyers cutting posting 7¢/bbl—to top of $2.83 for gravity and above—in West Central Texas and the Texas Panhandle.

Purchasers generally said reduction brought these oils in line with "refining values." On the other hand, Pennsylvania-grade crudes got two advances totaling 23¢/bbl, boosting price for Bradford district oil to $4.68.

The industry came through the 34-day steel strike in better than expected shape. Low sulfur residual fuel prices recouped earlier losses in the Midwest, and although low sulfur oil dropped 10¢/bbl at the Gulf, resumption of some buying activity tended to steady prices.

Light fuels reacted seasonally in most areas. Reductions of 0.25¢ to 0.5¢ were made in prices at the Gulf. Prices were subject to shading on spot basis along the East Coast, and similar reports were heard from the Midwest and Mid-Continent areas.

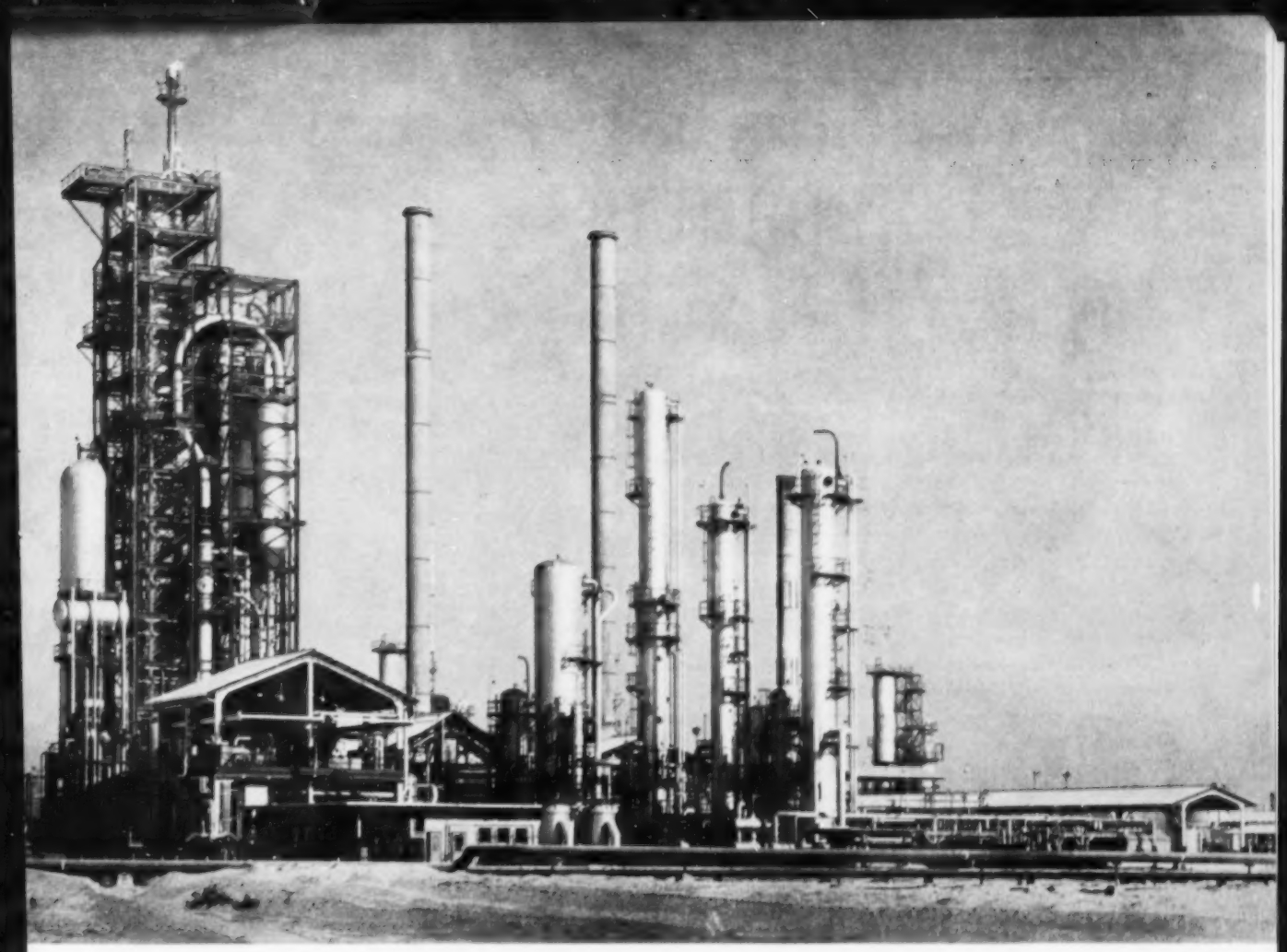
There was some unsteadiness in gasoline prices in the Midwest and Mid-Continent areas. Quotations moved up 0.25¢/gal in the Chicago District, but in the Twin Cities price shading led to reductions of the same amount. Reports persisted of below-market offerings at various other Great Lakes Pipe Line terminal points also.

Bright spot in the gasoline picture was the fair-trading of branded motor fuels by major suppliers at the retail level in eastern states where price wars have been chronic for several years. Higher pump prices held steady in New Jersey. And, under the fair-trade shield, retail postings jumped as much as 10¢/gal in some New England states.

Looking Ahead

. . . **Miniature atomic refinery** has been built by Atlantic Refining Co.'s nuclear technologists at the Brookhaven National Laboratory, Upton, L. I. The "loop reactor" permits continuous flow of oil samples through the laboratory's atomic pile, simulating processing of petroleum under atomic radiation.

. . . **Coal aromatics will use petroleum processes.** Jones & Laughlin Steel Corp. will build a 1300 b/d Hydrofiner and 1340 b/d Udex unit at Aliquippa, Pa., to treat aromatics gotten by coking of coal for metallurgical coke. The processes will replace sulfuric acid washing, and allow company to meet more rigid specifications by aromatics users.



Lummus, Aramco teamwork supplies more quality gasoline from Saudi Arabia

In August at Ras Tanura, Saudi Arabia, a 12,500 B/D Fluid Hydroformer is undergoing its first turnaround since it came on stream in October, 1955. For the past 10 months this unit has supplied 92.5 F-1 clear octane blending stock to European and Middle East markets, where the need for quality gasoline is growing rapidly.

The Hydroformer was designed and engineered by Lummus for The Arabian American Oil Company under license from Esso Research and Engineering Co. The process, though more complex than any other in the Ras Tanura Refinery, was designed for ease of operation to fit in with the Company's policy of training and upgrading Saudi Arab nationals to the fullest extent.

Close liaison among the three groups during all phases of design and construction has paid off. Startup was smooth, with all facilities operating at full design rate soon after feed was introduced. And the plant has been operating successfully ever since, at and above the design rate. In all cases, hydroformates of premium quality have been obtained from the high paraffin – low naphthene stocks characteristic of Arabian crudes.

Test runs at feed rates of 12,500 – 16,300 B/D have yielded products of 94.8 – 87.4 F-1 clear octane. There has been no difficulty in making the 92.5 octane design product at rates up to about 13,500 B/D. These tests indicate that hydroformates close to 95 F-1 clear can be produced in good yields, and should higher quality be needed, more severe hydroforming conditions appear to be feasible.

Aramco's new Hydroformer is one of over 700 major Lummus installations throughout the world. The excellent operating record of this new unit, and of Lummus plants in general, proves the case for coordinated direction of a project from idea to startup. Lummus teamwork can pay off on your next project.

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Indiana. *Engineering Development Center:* Newark, New Jersey.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

Compatible Coexistence in Petrochemicals

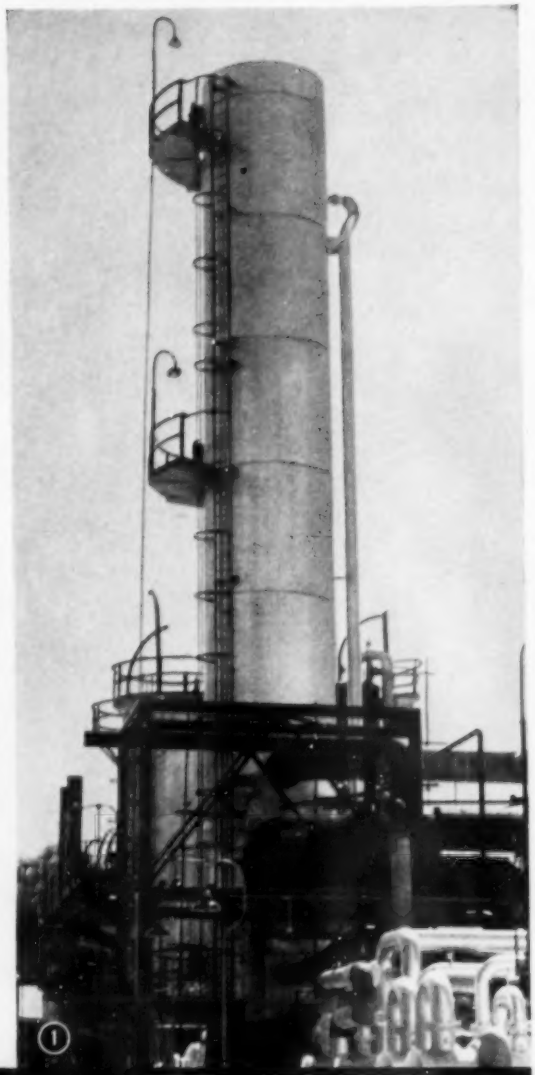
Compatible coexistence between highly corrosive chemicals and process or storage equipment is a requirement well known to Graver In fact, Graver fabricating skills with a variety of alloys is why the petrochemicals industry, ever since its start, has turned to Graver for alloy process equipment, pressure vessels and storage tanks.

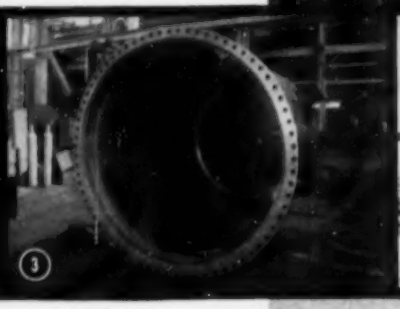
Graver fabrications in alloys are demonstrated by the petrochemicals installations illustrated here. The specifications are never too exacting, the project never too big to be fulfilled by Graver's country-wide manufacturing facilities.

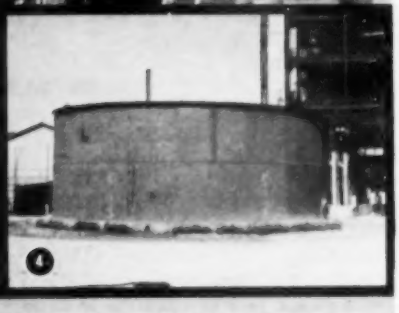
"Call in Graver" is a compliment the petrochemicals industry pays us with great regularity May we show you the advantages of calling in Graver the next time you have a project requiring alloy fabrication?

Some Examples of Skilled Graver Alloy Fabrications

1. 9′ by 68′ stripper column for a petrochemical plant
2. 12′ by 31′3″ aluminum storage bin for a synthetic fiber plant
3. 4′6″ by 8′ solid stainless nitration vessel for a nitroglycerine plant
4. 41′ by 15′ field-erected Monel tank for acid residue







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Free-Piston Automotive Engine—It Could Change the Fuel Picture

LATEST entry on the growing list of developments that may affect future automotive fuels is the combination free-piston-gas turbine engine. General Motors Corp. has claimed the first installation in a car of a free-piston power plant, and reports that the engine has been tested on fuels ranging from high-octane gasolines to heavy bunker "C."

At least one other manufacturer, Ford, is known to have such a unit under test. Other manufacturers are watching developments with interest if not excitement.

First reports of GM's 250 hp experimental model indicate that the engine has better fuel economy and a less sensitive fuel taste than gas turbines. In fact, one experimental unit has been fueled with whale oil, peanut oil, and other vegetable oils.

Basically, the free-piston engine operates on a two-stroke combustion cycle. Two opposed pistons with no mechanical connections are confined within a single cylinder. The pistons compress air between them on the compression stroke. Fuel injection and combustion then drives the pistons apart on the power stroke. Air, compressed between the cylinder end and the pistons on the power stroke, acts as a flywheel and "bounces" the pistons back together for the compression stroke, completing the cycle. Part of this compressed air flows into the combustion space for scavenging and for combustion air for the next power stroke.

Principles of the free-piston engine have been known for more than 30 years. However, application of the engine—mostly in Europe—has been limited to such large installation as ship propulsion, locomotives, stationary power plants, and air compressors.

GM claims its engineers are the first to design a free-piston engine into such a small compact unit. Their engine has two parallel cylinders, each containing a pair of horizontally opposed pistons, a departure from previous free-piston designs. Exhaust gases are piped to a gas turbine that powers the rear wheels of the car.

The exhaust gases from the free-piston engine are of comparatively low temperature (about 900° F). This lessens the need for critical materials in turbine blading and simplifies lubrication problems.

Other bright spots—besides fuel—in the free-piston picture, compared with gas turbines: (1) it can be built of non-strategic materials; (2) it has fewer rotating parts than either piston engine or gas turbine; (3) it runs very smoothly; and (4) its efficiency approaches that of the diesel engine.

Up to now, the gas turbine has generally been considered the most likely successor to the piston engine. The free-piston engine could change that. GM says that it offers many possibilities for buses, trucks, and military vehicles, in addition to passenger cars.

Evidence that oil companies are taking the free-piston engine seriously is the recent announcement that The Texas Co. is conducting tests to determine the engine's fuel and lubricant requirements. Texaco believes that the new engine will have increasing use in this country.

Most automotive engine research in recent years has carried the implication that new fuels will be needed for the cars of the future—the free-piston engine is another step along the way. —R.E.C.

Coke and Fuels from "Gilsonite" Necessity Is the Mother of . . . etc.

IN 1952, the Paley report (by the President's Materials Policy Commission), recommended help by the government in the development of oil from shale and other solid hydrocarbons. But industry is not waiting for government assistance. It's pushing ahead on its own, opening the curtains for a look at tomorrow's production of gasoline from solid hydrocarbons.

The most recent company to announce plans is the American Gilsonite Co., jointly owned by Standard Oil of California and Barber Oil Co. Their plans call for a refining process even more unusual than the Swedish Aspeco process for recovering oil from shale, which is being pioneered here by Oil Shale Corp.

American Gilsonite plans to use both conventional and newly developed techniques for mining, transporting, and processing solid "gilsonite" into coke and fuels. Products from the $16-million plant will be gasoline, distillates and high-quality, electrolytic coke for arc furnaces.

Technically, "gilsonite" is the company's trade name for unintaite, a solid asphaltite with high resin but very low sulfur content. Only in the Uintah Basin of eastern Utah and western Colorado has this unique deposit been found. However, it seems to be a geological cousin of oil shale found just the other side of the mountains.

(Continued on next page)

The refinery will be located at Grand Junction, Colorado, and will be connected by a 70-mile pipeline to the mining site. A unique wet-mining technique has been developed to reduce the hazard of dry mining, present because gilsonite forms a highly explosive dust underground.

Transporting the crushed ore as a 20-60% slurry with water will be accomplished by pumping at high velocity through a 6-in line. The 70-mile pipeline will slope continuously from the mine to the refinery to prevent gilsonite slurry from settling out in low places.

The refinery near Grand Junction will use conventional process equipment but will not include any crude still. Instead, the dewatered gilsonite will be melted in a tank and fed to a delayed coker. Feed will consist of one-third fresh oil and two-thirds recycle. The vapor-liquid from the coker will go through conventional processing to yield gasoline naptha, which will be reformed in a UOP platformer. The coke will go directly to a calcining plant.

Although this unusual processing of a solid hydrocarbon is economical because of the isolation of the refining area from other sources of crude oil, it may point the way toward successful recovery of "petroleum products" from other non-liquid sources. This is a step that is receiving greater attention in the drive to meet the energy needs of tomorrow. —W.A.B.

New Process Water Source May Result from Evaporation Study

WATER WORRIES of refiners and petrochemical operators may be eased if current research produces a practical, economical way to control evaporation losses from fresh water reservoirs. Results may not be too far off.

Water loss by evaporation in some areas is more than twice consumption. Effective control of these losses could change this ratio and, in effect, be a new source of water for thirsty industries already facing increased demands and dwindling water supplies.

Southwest Research Institute, of San Antonio, Texas, is presently conducting studies of evaporation control by use of monomolecular films on water surfaces.

This was brought out in a report, "Recent Advances in Reservoir Evaporation Control," by Russell G. Dressler, manager of chemical engineering research, for Southwest Research Institute. Dr. Dressler addressed the Arkansas-White-Red Basin Inter-Agency Committee meeting, Santa Fe, New Mexico, May 3, 1956.

Reports from other countries, notably Australia, indicate that such a film will reduce evaporation losses by as much as 70% with a normal reduction of about 45% predicted.

Certain compounds related to natural fats and oils, such as fatty acids and fatty alcohols, spread over water in a film of monomolecular thickness. These molecules have in their molecular structure a group that is attracted to water, and the molecules stand on end, closely packed, to form a barrier to water evaporation.

Organic materials that have been used in the research program up to now have been well known, commercially available compounds. They can be produced from tallow or similar sources, in large quantities for about 30¢/lb or less. Because these compounds will form protective layers of molecular thickness, they will provide extensive coverage per pound. Assuming a very conservative film life of one month, and water conservation of 45%, the cost of water thus conserved will be about 80 cents per acre-foot.

This is about the cost of untreated surface water in areas where water is plentiful and cheap—and considerably less than water in more arid regions.

Australian research has centered on the use of cetyl alcohol in reducing evaporation from large bodies of water. Other studies in this country have indicated that fatty acids, the C_{17} to C_{20} acids, are markedly effective in reducing evaporation losses.

Southwest Research's program, sponsored by 39 companies and municipalities, including 6 petroleum processing or petrochemical firms, is aimed at selecting the most practical and economical material and methods to be used for film evaporation retardents.

Although results from tests in Australia will be appraised, differences in climatic conditions in this country will necessitate independent studies to determine the effects of different temperatures, wind action, dust, and differences in water quality.

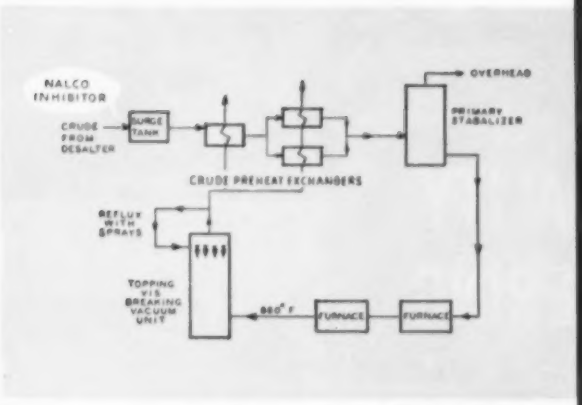
The Institute's program will also investigate the effects on marine plant and animal life, the effects of wave action, freezing, dust, and shore losses. Most of the biological work will be done by the U. S. Public Health Service.

Successful evaporation control could mean a very real new supply of water for industrial expansion, and increased demands. Better still, it promises to ease the "summer squeeze" experienced by practically all refineries and consumers of large quantities of water. —R.E.C.

Nalco INHIBITORS STOP CORROSION and FOULING

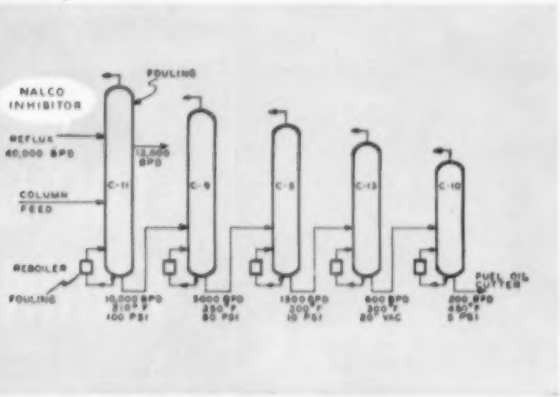
Every Step of the Way

HERE are four typical stages of refinery production where Nalco Inhibitors stop corrosion and fouling. There are many others, too. In fact Nalco Inhibitors are effective every step of the refinery way. Ask your Nalco Representative or write direct.



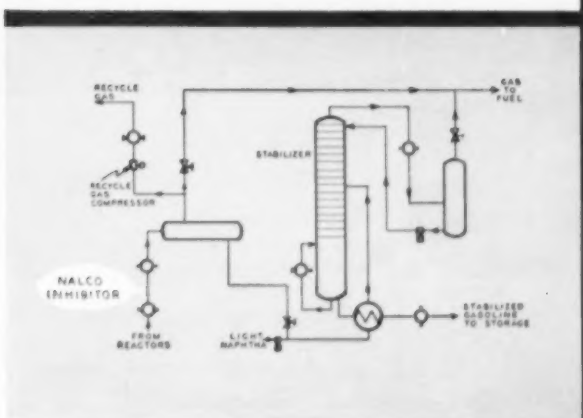
CRUDE PREHEAT EXCHANGERS

The Problem: Fouling. *The Treatment:* 15 ppm of Nalco Inhibitor. *The Results:* Normal temperatures regained in exchangers after five weeks of treatment. Actual reduction of 4 days of downtime due to cleaner condition of treated units.



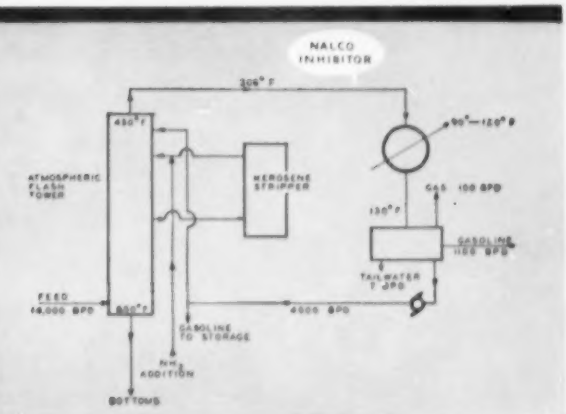
ALKYLATION SYSTEM

The Problem: Reboiler fouling. *The Treatment:* Nalco Inhibitor fed to reflux of tower C-11. *The Results:* No water washing or mechanical cleaning of system needed after full year of operation. Refinery costs and inconvenience reduced considerably. Greater production realized.



PLATINUM REFORMING UNIT

The Problem: Severe corrosion of exchangers and accumulator after the reactors due to an unusually high halogen acid contamination which held pH about 1.3. *The Treatment:* Nalco Inhibitor into reactor effluent. *The Results:* Iron content reduced from 13.9 to low of 0.73 lbs. per day, far lower than with other inhibitors at greater dosage.



DELAYED COKING UNIT

The Problem: Corrosion of overhead condenser, accumulator and stream pumps. Small amounts of iron sulfide "scaling" in flash tower. *The Treatment:* Nalco Inhibitor added to overhead stream. *The Results:* Iron content of tail water reduced from 300-1000 ppm to approximately 1-20 ppm. Corrosion and scaling stopped.

NATIONAL ALUMINATE CORPORATION

6258 West 66th Place • Chicago 38, Illinois
Telephone: POrtsmouth 7-7240
CANADA: Alchem Limited, Burlington, Ontario
NORTHWESTERN UNITED STATES, HAWAII and ALASKA
The Flox Company, Inc., Minneapolis 3, Minnesota
ITALY: Nalco Italiana, S.p.A.
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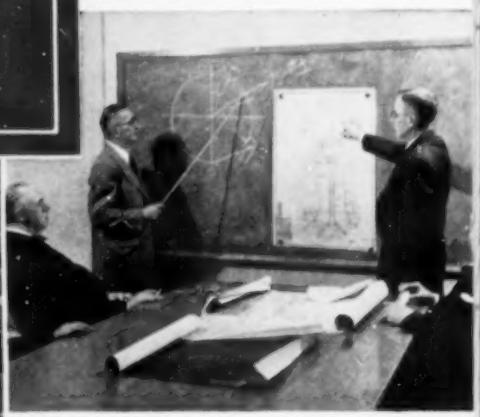

McKee engineers call on many years of experience on plants all over the world to solve design problems.

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Letters

Two-Stage Cracking

To The Editor: Thank you for the coverage given to our paper, "Two-Stage Fluid Catalytic Cracking—A New Technique," in your June issue, pp. 54-57.

Unfortunately, in your re-drawing of the Figs. 1 and 2, an error has been made in the identification of some of the curves and also in the captions. The green lines refer to *riser* cracking rather than *two-stage* cracking. The second paragraph of the article also should be revised accordingly. The first sentence on p. 56 describes Figs. 1 and 2 correctly.

Two-staged yields, which are the sum of the yields from the riser first stage plus subsequent cracking of the first-stage gas oil, are given correctly in Tables 1, 5 and 7.

Julius D. Heldman
Shell Oil Co.
New York City

• *Thank you, reader—and author—Heldman. In our zeal to show more clearly and vividly the striking difference between two-stage and conventional dense-bed cracking in their effects on gasoline yields and coke laydown, we missed the fine point that Figs. 1 and 2 actually showed a difference between conventional cracking and the first stage only of the two-stage technique.*

Get it Straight

To The Editor: You guys sure gave me the works. I'll admit I enjoyed seeing my portrait in your last issue, and I'll admit I enjoyed reading the "Bull Pen" and "The Almost Lost Weekend." But the name is Miretti, NOT Monetti. I'll bet that the guy who thought up us Bull Pen characters is just as peeved as I am.

Do me a favor and spell it right from here on in.

Dan Miretti
The "Bull Pen"

• *Editor's Note: Griper Miretti, of course, is fictitious. The "error" occurred in the first appearance of our new department, "The Bull Pen," [Petroleum Processing, August, pp 60-61]. This month's Bull Pen article appears on p. 155.*

Unbeatable for fast, clean pipe or conduit cutting . . .

efficiency-balanced
RIDGID
Heavy-Duty
Pipe Cutter

7 models for ⅛" to 6" pipe and conduit

It's a tool that knows its business, that comes to your hands like an old friend. It rolls easily through any pipe or conduit, scarcely a trace of burr. Strongly built, guaranteed not to warp or break, always tracks perfectly. Thin-blade or heavy-duty cutter wheels (special wheels for stainless or cast iron). For pipe or conduit cutting that's a satisfaction, buy RIDGID's at your Supply House.

RIDGID
4-WHEEL
for easy cutting in tight places

RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company, Elyria, Ohio, U. S. A.

PROVEN
BY PERFORMANCE

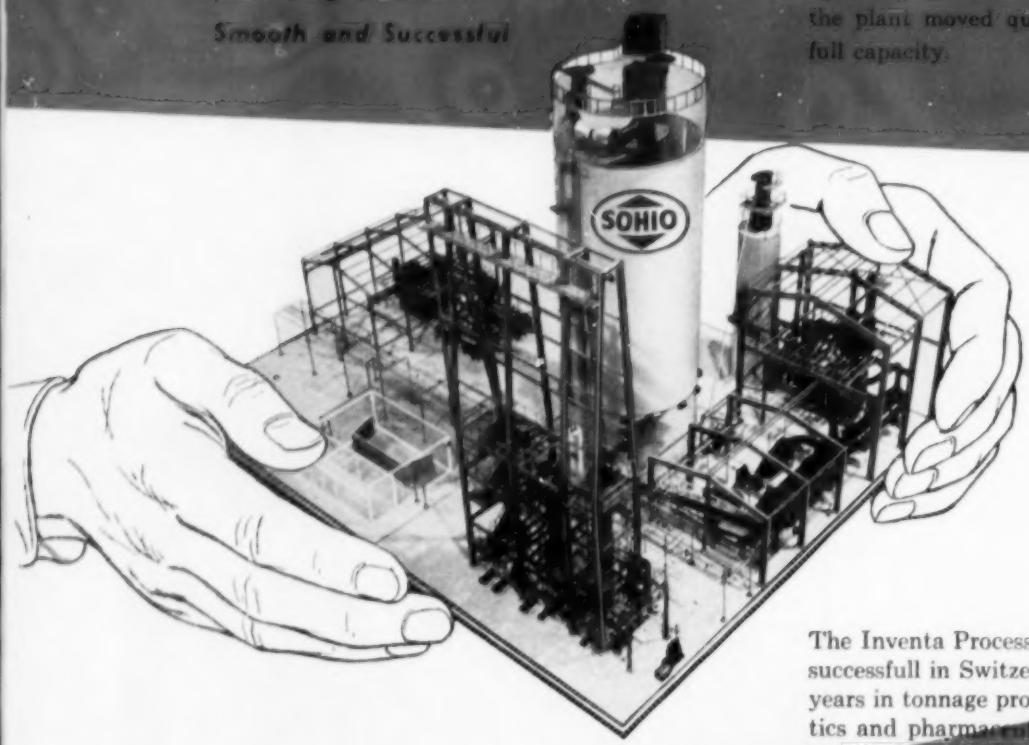
INVENTA-VULCAN
UREA PROCESS

Sohio Startup According to Plan— Smooth and Successful

The first Inventa-Vulcan urea plant in the United States is now on stream. This new plant was designed and built by Vulcan Engineering Division—licensors of the Inventa Process in the U. S. and Canada—for Sohio's $17,000,000 petrochemicals installation at Lima, Ohio.

Within six hours after startup high quality urea was produced. Ease and reliability of operation were demonstrated. Startup produced first urea solutions and then prills for agricultural purposes exactly as planned.

Corrosion, traditionally present in urea synthesis, was conspicuously absent, as were clogged lines and contaminated product. No significant problems were encountered and the plant moved quickly and smoothly to full capacity.



VULCAN

The Inventa Process has been commercially successfull in Switzerland for more than six years in tonnage production of urea of plastics and pharmaceutical grades. Additional details about the Inventa-Vulcan Urea Process may be had by writing to the Vulcan Engineering Division.

VULCAN ENGINEERING DIVISION

VULCAN—CINCINNATI, INC., General Offices and Plant, CINCINNATI 2, OHIO

BOSTON CHARLOTTE, N. C. DENVER HOUSTON SAN FRANCISCO

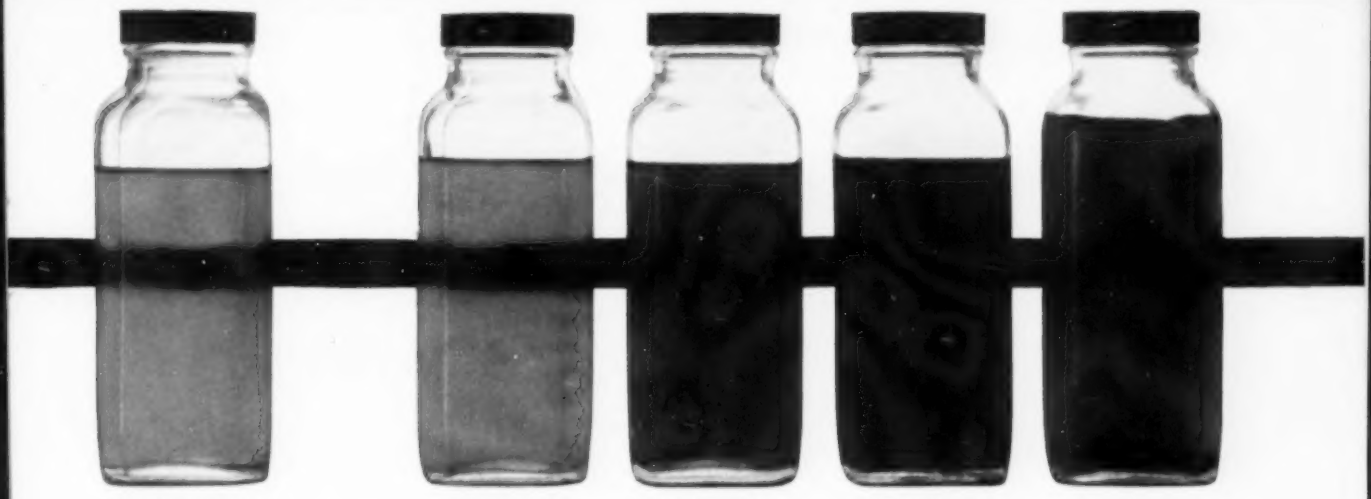
VICKERS VULCAN PROCESS ENGINEERING CO., LTD., MONTREAL, CANADA

DIVISIONS OF THE VULCAN COPPER & SUPPLY CO.

VULCAN ENGINEERING DIVISION • VULCAN MANUFACTURING DIVISION • VULCAN CONSTRUCTION DIVISION

Straight-Run Quality

FOR CRACKED FUEL OILS



DIRECT FROM REFINERY STREAM FRESH FUEL OIL

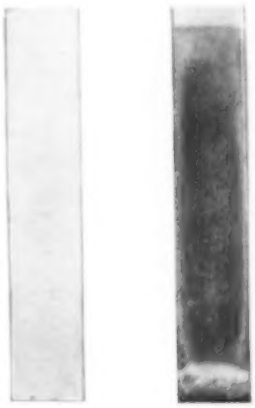
FUELGUARD PROTECTED AGED FUEL OIL

ADDITIVE A TREATED AGED FUEL OIL

ADDITIVE B TREATED AGED FUEL OIL

NO ADDITIVE AGED FUEL OIL

Test results with 50-50 blend of cracked and straight-run fuel oil. Bottle at left contains a blend of oils taken from the refinery streams. The four bottles, at right, contain the same oil blend, which was treated as indicated, and then aged six weeks at 120° F. Competitive additive A only inhibits sludge. Competitive additive B only disperses sludge. Fuelguard provides two-way sludge protection.



Fuelguard Treated Oil

Untreated Oil

Full advantage of expanding fuel oil markets goes to the refiner who can supply more cracked fuel oils of *straight-run quality*.

Fuelguard is the additive providing full quality control for fuel oils.

Sludge-Free. Fuelguard's two-way sludge control prevents clogging of filters and burners. Fuelguard inhibits gum and sludge formation AND disperses any existing sludge . . . gives the double action needed for sludge protection, as shown in photographic test results above.

Lighter Color. Fuelguard gives lighter, clearer fuel oils with full sludge control. The light colored, haze-free appearance gives real sales appeal to fuels.

Rust Protection. Fuelguard controls rusting and corrosive pitting of fuel oil tanks and pipelines whenever water is present. Test strips, at left, show Fuelguard control of this destructive action.

No Emulsions. Fuelguard does not emulsify water in the fuel oil or leach out of fuel oil into water layers.

No Sparking or Deposits. Fuelguard is completely combustible and ashless—no metallic ash to cause deposits and exhaust sparking.

Corrosion test on steel in the presence of water and fuel oil.

If your problem is preventing sludging and excessive darkening of distillate fuel oils, you'll find Fuelguard the economical solution. Fuelguard is available in drums and tank cars for your immediate protection.

Manufacturers of fine industrial chemicals

Carlisle Chemical Works, Inc.

Reading, Ohio

FUEL FOR FLIGHT

The photo shows a recently-installed Petreco Electrofiner at the Watson Refinery of Richfield Oil Corporation. It is a two stage, 8 foot diameter unit, designed to caustic treat and water wash, or to acid treat and caustic wash. As this photo was made, the Electrofiner was acid treating and caustic washing jet fuels; plainly visible in the sky are jet vapor trails, completing the cycle—from manufacturing process to end use.

Electrofining removes tarry acids and gum-forming materials from jet fuel components. It insures color stability and yields a product which consistently passes government jet fuel specifications (JP-4).

For modern, precision-controlled treating of any distillate stock, Petreco Electrofining is the answer. Whether you plan to use it in a new refinery, or to replace obsolescent gravity treaters, Electrofining costs less to install, requires only a small ground area, fewer pumps and less piping. It requires less chemical, yet delivers a better product. Get all the facts, today.

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A DIVISION OF PETROLITE CORPORATION

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1390 E. BURNETT STREET, LONG BEACH 6, CALIFORNIA

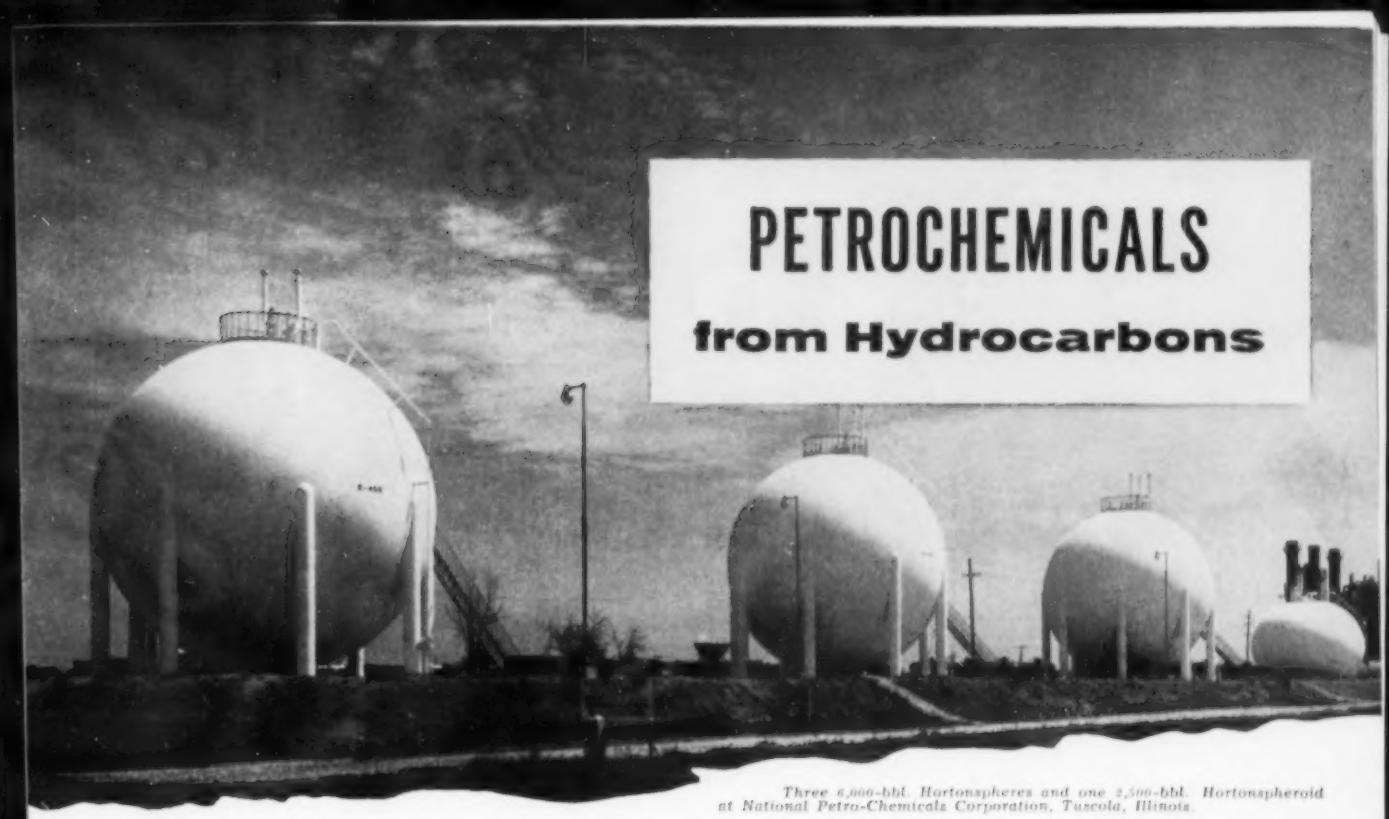
SPECIALIZED PETROLEUM PROCESSING

DESALTING • DEHYDRATING • DISTILLATE TREATING • LUBE OIL TREATING

SEDIMENT SEPARATION

DT 6-4

(To obtain more data on advertised products see page 208)



PETROCHEMICALS
from Hydrocarbons

Three 6,000-bbl. Hortonspheres and one 2,500-bbl. Hortonspheroid at National Petro-Chemicals Corporation, Tuscola, Illinois.

. . . another job that demands expertly engineered tanks and towers

. . . and CB&I has complete facilities to engineer, fabricate and erect them all. Four strategically located plants can provide solid, lined or clad steel structures built to the most exacting specifications. The towers, Hortonspheres® and Hortonspheroid® shown here, built for that brawny "infant" industry of petrochemicals, were fabricated and erected by CB&I for J. F. Pritchard Company and the Lummus Company and are located at the National Petro-Chemicals Corporation, Tuscola, Illinois.

Write our nearest office for further information on expertly engineered steel plate structures by CB&I . . . from tanks to towers.

A 6½-ft. diam. by 73-ft. stripper tower.

B 5½-ft. diam. by 88½-ft. absorber tower.

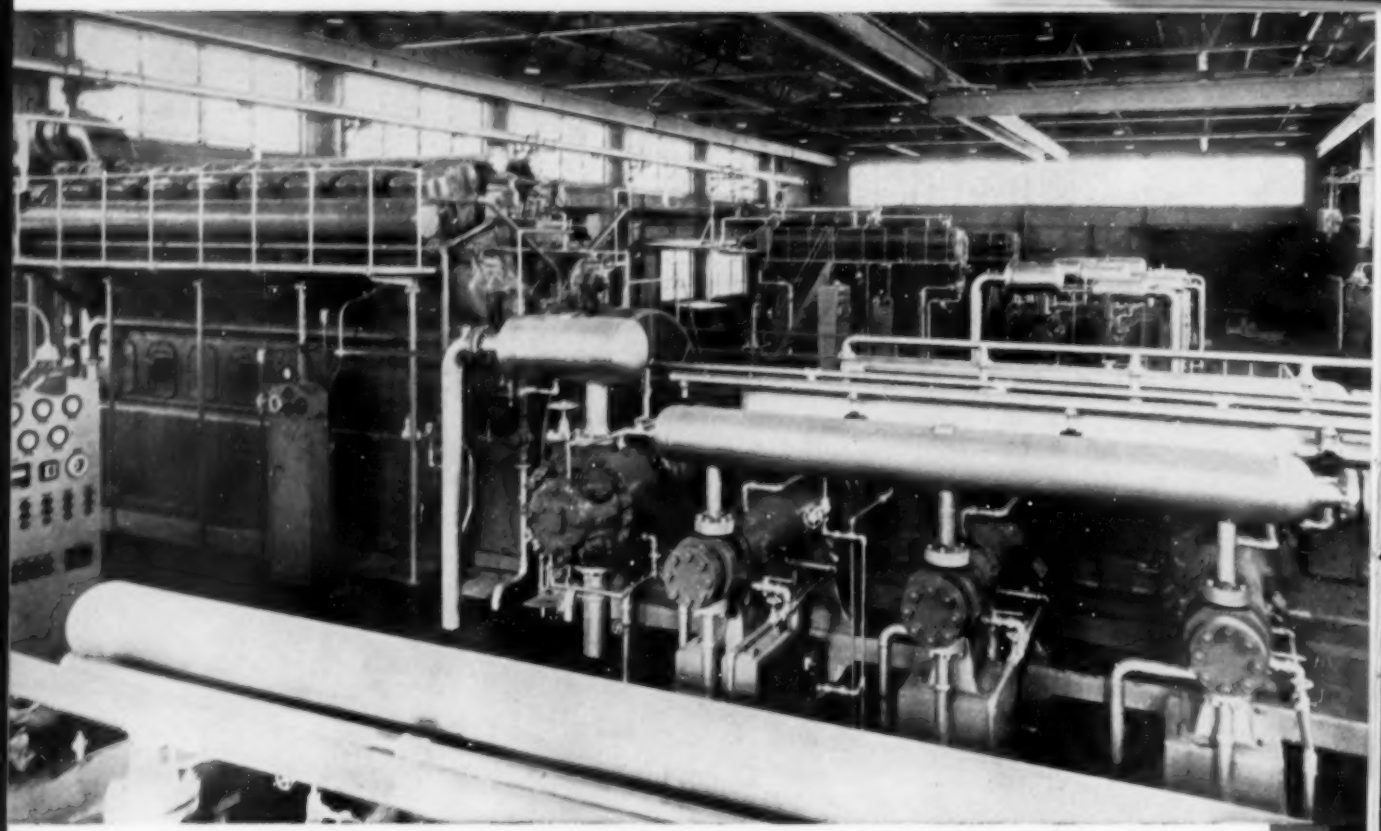
C 6½-ft. diam. by 20-ft. accumulator tanks.

CB&I

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa

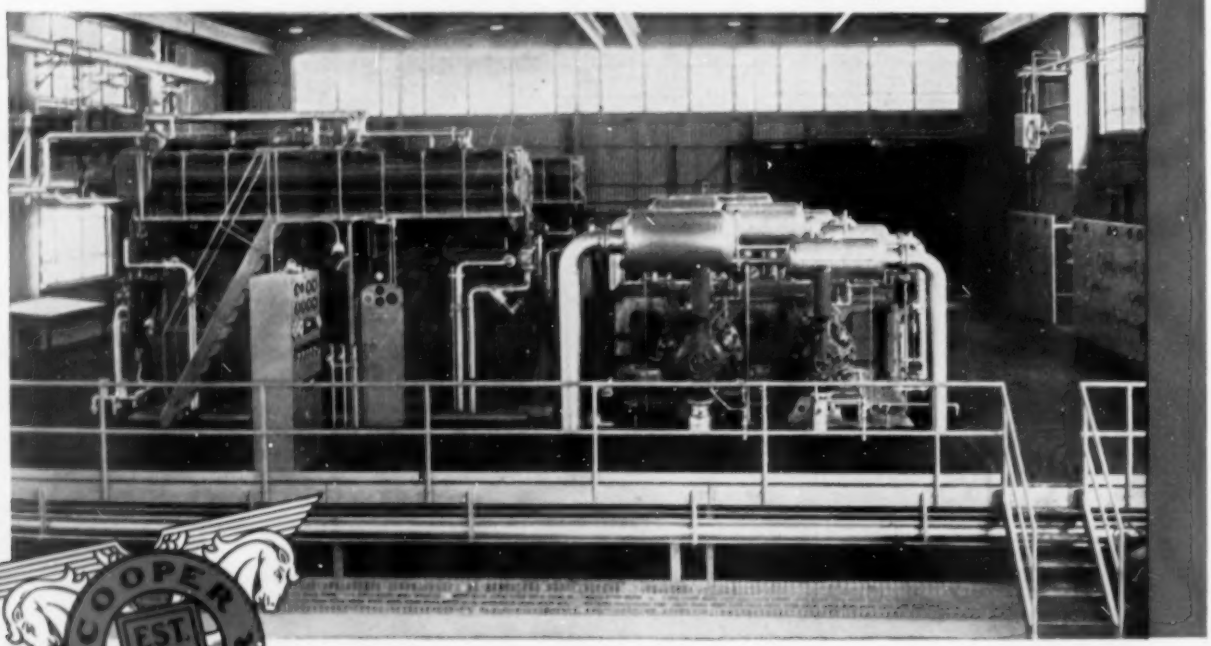
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY *and* GREENVILLE, PA.



ABOVE — In the foreground are LSV engines directly coupled to JM-8 compressors. In the background can be seen 8-cylinder LS engines coupled with JM-5 compressors. Engineering and construction of C.F.C.A. plant was handled by The Foster-Wheeler Corp., New York City.

BELOW — This view of the C.F.C.A. plant at Lawrence, shows the two 8-cylinder LS engines driving JM-5's for the efficient compression of air, natural gas and nitrogen.

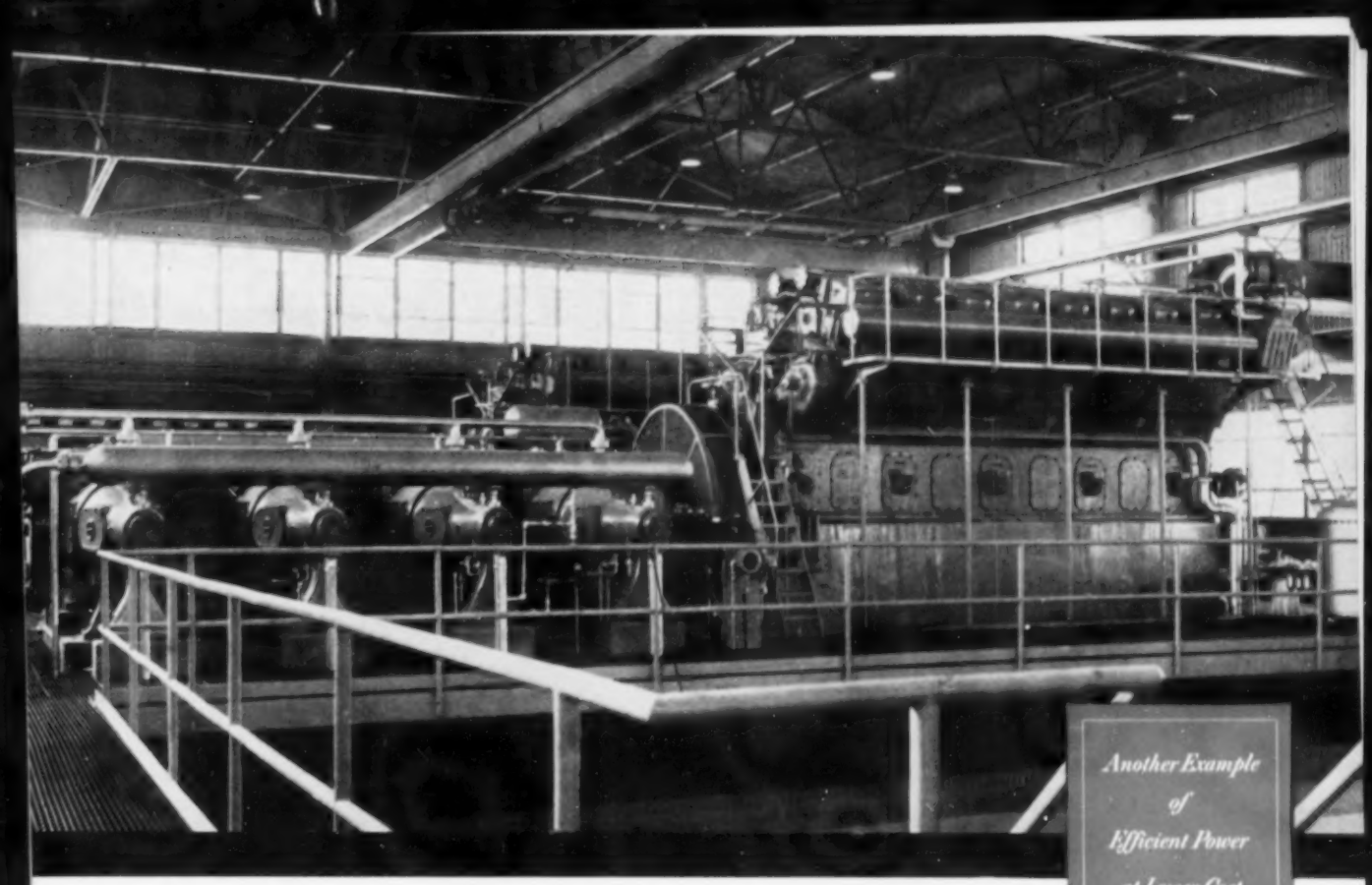
RIGHT — These two 16-cylinder Cooper-Bessemer LSV engines in the Lawrence chemical plant total 5074 horsepower. They drive JM-8's for the compression of ammonia synthesis gas to 12,100 psia.



COOPER BESSEMER EST. 1833

COMPRESSORS Reciprocating and Centrifugal DIESELS
GAS ENGINES · GAS-DIESELS

Houston, Dallas, Gregston, Pampa and Odessa, Texas · Seattle · Tulsa · Shreveport · St. Louis · Chicago



Another Example of Efficient Power at Lower Cost

Cooper-Bessemers at C. F. C. A.'s Lawrence Plant

UNIQUE! IN SIZE . . PERFORMANCE . . ECONOMY

• In Cooperative Farm Chemical Association's $16,000,000 Lawrence, Kansas plant, the largest engines and largest compressors manufactured by Cooper-Bessemer are combined to offer unitized machines boasting important advantages.

Two giant 4-cycle turbocharged LSV-16 engines, rated 2537 hp at 240 rpm, are directly connected with JM-8's for compressing ammonia synthesis gas from 275 psia to 12,000 psia. Obviously this big-unit setup meets requirements with far fewer engines than would be needed otherwise, resulting in less piping, less foundation and less supervision. What's more, there's previously unheard of fuel economy.

Similarly, the plant contains two LS-8 engines, rated 1852 hp at 330 rpm, combined with JM-5's for the compression of three separate gases on three individual services . . . air from 120 psia to 630 psia, natural gas from 115 psia to 430 psia and nitrogen from 35 psia to 330 psia.

Although scheduled for continuous full-load duty, these Cooper-Bessemer units can be easily operated at variable loads as required. In addition, they offer *extra* economy because they can operate efficiently, dependably on natural gas, diesel fuel or any combination of these fuels.

For information on new operating economies possible in *your* service, contact any of the Cooper-Bessemer offices listed below.

by **Cooper-Bessemer**

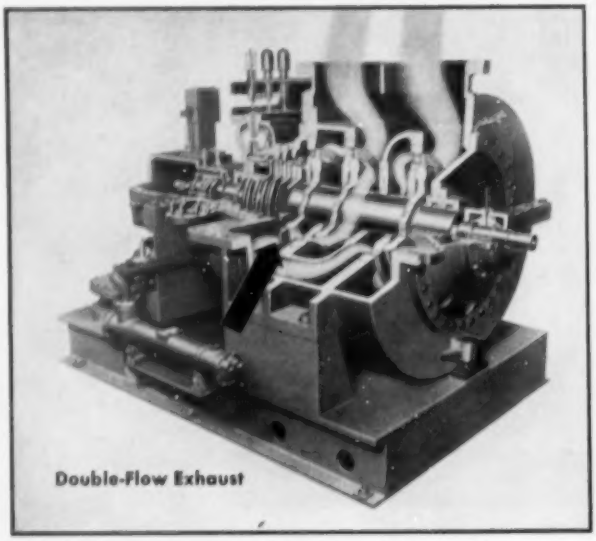
MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

New York City Washington, D. C. New Orleans Los Angeles and San Francisco

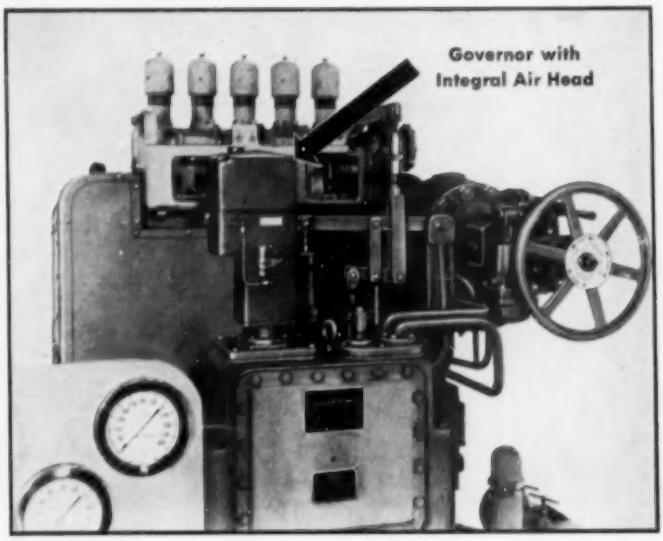
Cooper-Bessemer of Canada, Ltd.

11304, 119th St., Edmonton and 615 Second St., S.W., Calgary, Alberta, Canada

In high-speed turbines . . . why does in total horsepower and



GREATER RELIABILITY. Worthington's rugged construction pays off in extra reliability. Solid rotor for modern high speeds, double-flow exhaust where large volumes of steam are used in condensing operation, and Kingsbury type thrust bearings are just a few of the features that assure safety and dependable service on your vital compressor and blower drives.



ACCURATE SPEED REGULATION. Exclusive Worthington governing system using governor with integral air motor gives you speed control response to .04 psi change in control pressure. And it provides for remote automatic operation if you need it. The oil relay type governor so equipped instantaneously controls pressure or volume delivered by the compressor regardless of steam variations.

Where turbine-driven compressors and blowers are used, down-time is usually mighty expensive. Particularly so if failure can bring a continuous process to a standstill. In the case of high-speed/high-horsepower compressor-drive turbines, your surest way to design reliability into your plant is to specify the turbine line with best *proven* performance.

Compressor-drive turbine installations up to 12,000 rpm, and 24,000 hp, show Worthington leads in application engineering, design, reliability.

Worthington compressor-drive turbines are conservatively built with all stresses carefully calculated and kept well within established safety margins. Also, measured load tests are performed on every unit at the factory with modern facilities, under the watchful eyes of highly trained personnel.

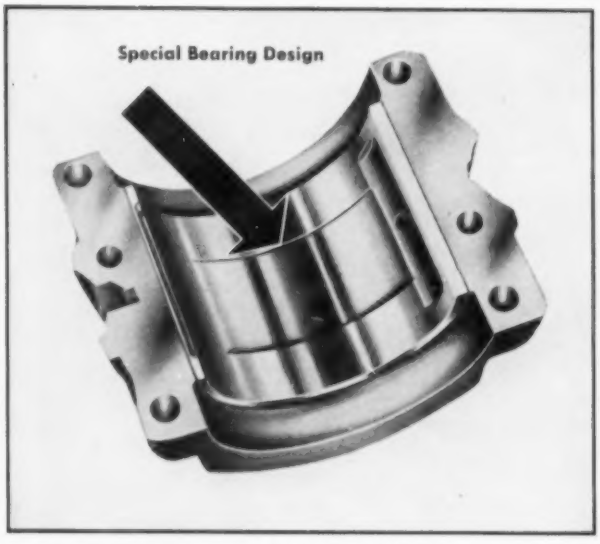
One feature seldom claimed is that of lowest price. That is inconsistent with quality, and quality is something Worthington engineers will not compromise. For critical operations, buying the best is lowest cost insurance against process equipment failure.

Get the complete story of high-speed/high-horsepower compressor-drive turbines by writing Worthington Corporation, A&SP-Turbines, Harrison, New Jersey. Ask for your personal copy of Bulletin 1966.

On Vital Compressor and Blower-Drive Applications . . . It Costs Less to Invest in the Best!

WORTHINGTON

WORTHINGTON lead all others number of installations?

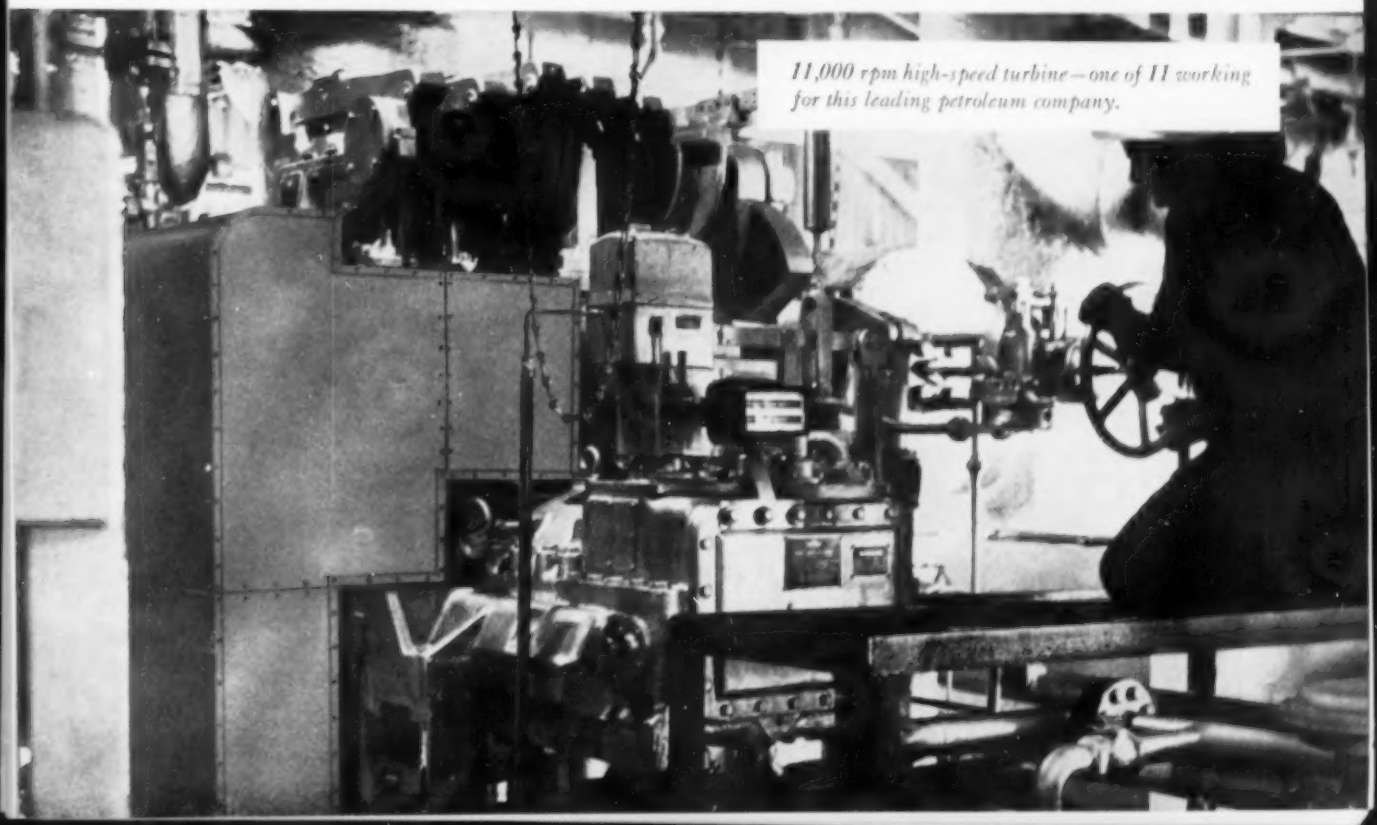


To meet turbine spec's. 4000 Hp- 7250 RPM -Steam 210 #-550° -26½"
WORTHINGTON GIVES YOU ALL THIS—CHECK AND COMPARE:

	Feature	WORTHINGTON	Company A	Company B	Company C
Rotor	Solid—to withstand extreme stresses.	✓			
Main Bearings	Anti oil-whip—for longer turbine life.	✓			
Thrust Bearing	Kingsbury type—for proven reliability.	✓			
Automatic Nozzle Control	Cam operated—for economy and better control.	✓			
Governor	Has integral air motor—for more accurate control.	✓			
Type Construction	Double flow exhaust for economy and long life.	✓			
Packing	Labyrinth—for most effective seal at high speed.	✓			
Test	Load test—to be sure you get what you ordered.	✓			

LOWER MAINTENANCE COST. One important example of construction used to help eliminate non-scheduled maintenance is Worthington's anti oil-whip bearing. During operation a pocket (arrow) in the upper half of the bearing builds up a pressure pad of oil. High pressure here creates a downward force on the journal, holding it in place in the bearing, preventing destructive vibration.

LONGER LIFE. A long, trouble-free life can be attributed to no *one* turbine feature, but rather a combination of many engineering advances. Compare design features yourself, one by one. Far ahead of any other manufacturer in the compressor-drive field, Worthington's first compressor-drive turbine built in 1927 is still working around the clock, in a large Eastern gas plant.



11,000 rpm high-speed turbine—one of 11 working for this leading petroleum company.

Traveloader placing heat-exchanger tubes on "Christmas Tree" racks to conserve yard storage space.

®Traveloader solves handling of bulky, heavy loads

Here is a revolutionary new material handling machine designed expressly for long, unwieldy awkward loads. It picks up loads from the side, carries them securely on the truck deck, and stacks them to a height of 12 feet. It operates indoors or outdoors, in 10 foot aisles, over paved or unpaved roadways—and over highways at speeds up to 30 MPH!

Traveloader is available with gas or diesel powered engine, in 10,000 and 12,000 pound capacities. Write for descriptive bulletin No. 1360.

No other ONE machine offers these features:

1. A *ONE MAN* operated lift truck and transporter.
2. SIDE LOADING for straight line pick-up and delivery.
3. CARRIES LOADS equally distributed over two axles and four pneumatic-tired wheels.
4. TRAVELS with payload up to 30 MPH.
5. STACKS LOADS 12 feet high from 10 foot aisles.

Airplane wings crated for shipment are easily handled by Traveloader.

Traveloader with master pallet and roller conveyor speeds loading of aircraft.

Baker® handling equipment

THE BAKER-RAULANG COMPANY

1248 WEST 80th STREET • CLEVELAND 2, OHIO

Subsidiary of Otis Elevator Company

5T6

LOOKING FOR EXTRA OCTANES?

...they've been found with

AEROCAT® CATALYSTS

A survey of 42 cat crackers showed that those using Aerocat were averaging 2⅓ octanes higher than comparable units operating with natural catalyst! But extra octanes are only one of the benefits assured by Aerocat. High throughput, low stack loss and excellent stability contribute to the high overall efficiency.

Equally important... behind AEROCAT'S *efficiency stands*

OPEN-EYED RESEARCH... that keeps making innovations in catalyst design... keeps looking for new ways to solve catalyst problems.

HARD-HEADED QUALITY CONTROL... that insists on "specification *plus*" in every carload that leaves the plant.

FIELD-TRAINED TECHNICAL SERVICE... that knows how to relate specialized knowledge of catalyst production to your cracking problems.

CYANAMID

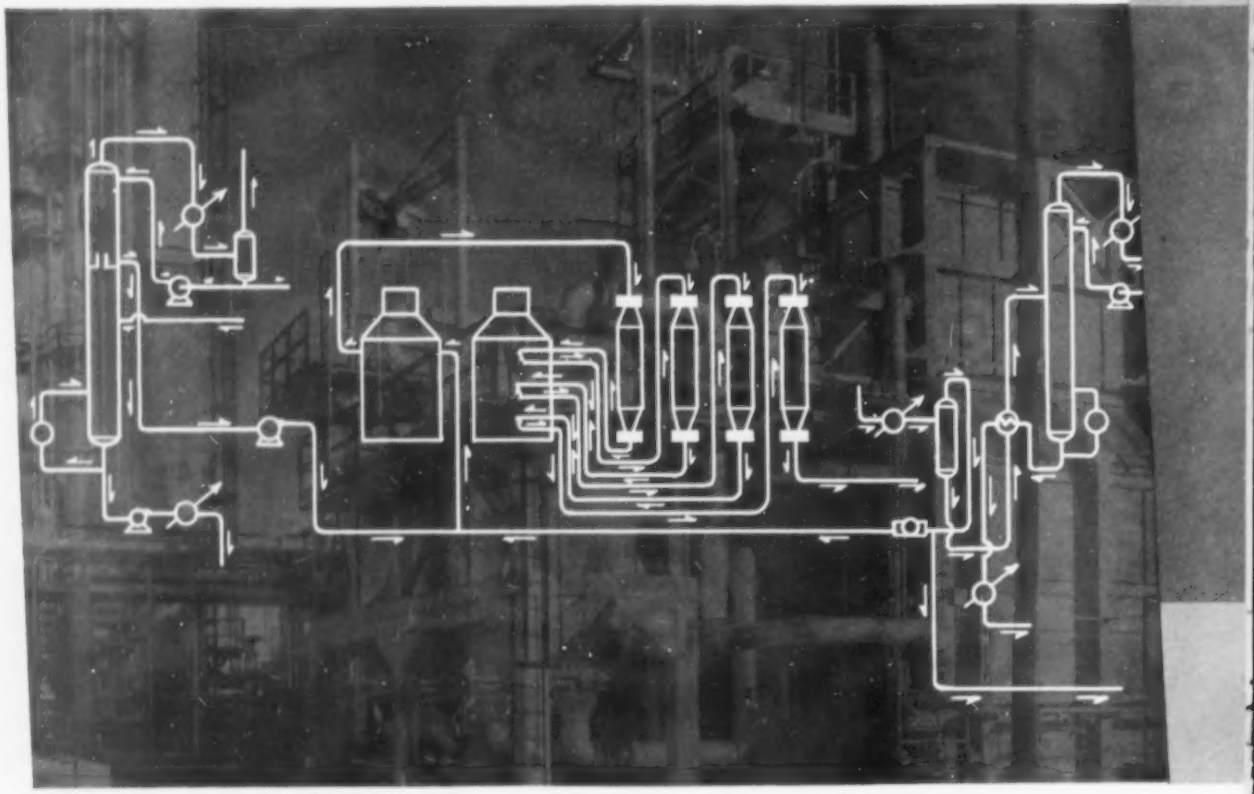
AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, New York

In Canada: North American Cyanamid Limited, Toronto and Montreal

TO GET THE MOST OUT OF

THIS IS THE GOAL OF EVERY REFINER AND HERE IS HOW UOP RESEARCH IS HELPING ATTAIN IT. . . .

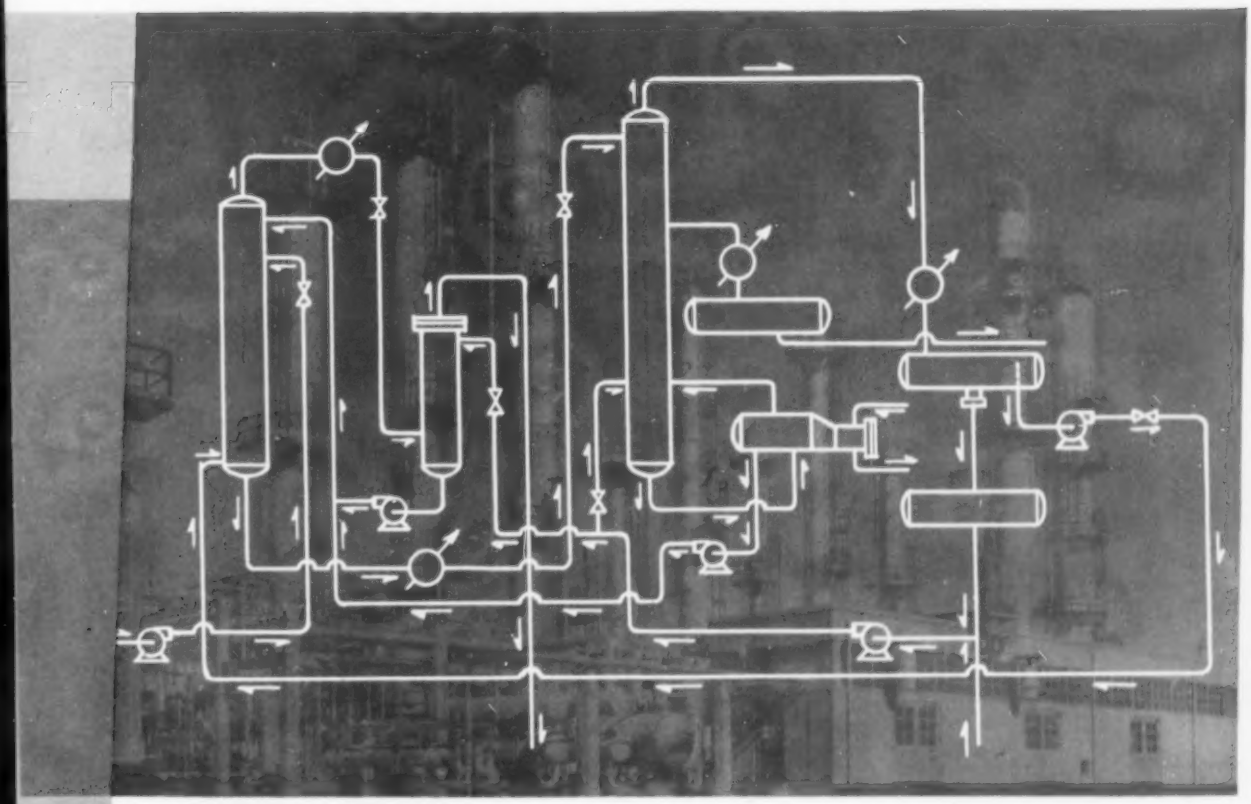
For more than forty years Universal has been developing improved petroleum refining processes, to help refiners fulfill the nation's need for motor fuels. Beyond this primary objective, UOP research has always considered the broader problem of helping the refiner get the maximum return from every barrel of oil he processes. One of our developments in petrochemicals is striking evidence of this.



Simplified flow diagram of Platforming Process

Platforming, developed by UOP and introduced in 1949, pioneered the use of platinum in a catalyst for refining gasoline and is today one of the world's most widely used processes. Early in its development, our research team realized that Platforming offered a practical means of helping meet the chemical industry's growing demand for aromatics. Experimentation indicated that, by employing certain modifications in operating conditions, high yields of aromatics were possible through Platforming. This was only a partial solution because the problem of separation of aromatics in the degree of purity required by the chemical industry still remained.

Every Barrel OF CRUDE



Simplified flow diagram of Udex Process

Udex, developed by Universal in cooperation with Dow Chemical Company, provided the answer. It successfully created and applied the separation equipment necessary to concentrate the aromatic hydrocarbons produced by Platforming into the form required by the chemical industry. This combination of UOP's Platforming and Udex processes, an outcome of a basic research program originally directed toward motor fuels, is an outstanding example of the broad scope of UOP research.

Universal research is continuing to develop and make available to all refiners, everywhere, not only new and improved processes for producing more efficient fuels for automotive engines, but also better ways of utilizing by-products from petroleum. In this way we believe we are truly helping the refiner to get the most out of every barrel of crude.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U.S.A.

Forty Years of Leadership in Petroleum Refining Technology

Why Oilwomen Everywhere are Saying...

"Have Magic Suitcase ...Will Travel"

Every woman is interested in beauty—clothes—homemaking. But not every woman knows how big a part *oil* plays in a woman's world! That's why the Oil Industry Information Committee sponsors a Women's Program.

Today, hundreds of oilwomen—industry employees and oilmen's wives—help tell the story of oil in an interesting and dramatic way. The "Magic Suitcase" is one way. It contains products made from petroleum—cosmetics, detergents, oil-based "miracle" fabrics and many other items a woman uses in her daily life. This demonstration—as well as other lectures and displays—shows her how *oil* and *oil* products help make her look more beautiful and make her housework much easier.

The Women's Program is only one of many ways through which your OIIC helps show the public that it is best served by a privately-owned, fully competitive oil industry. If *you* would like to aid in the Women's Program—or another of OIIC's many activities—contact the OIIC in your area today. You'll not only be helping your industry but you'll get a wonderful sense of personal satisfaction from it as well.

For the address of your local OIIC office, write to . . .

AMERICAN PETROLEUM INSTITUTE, 50 W. 50th St., New York 20, N. Y.

BETZ • *A Great Name In Water Conditioning*

They all work for you!

It takes the combined ability and experience of many people to engineer effective water conditioning.

Few plants, however, can afford to maintain or establish an internal staff capable of supplying the constant flow of engineering knowledge, the diversification of thinking, the thousands of creative and supervisory man-hours that are necessary to the engineering, planning, and control of an effective water conditioning program.

By assigning the responsibility for result-getting water conditioning in your plant to the Betz Organization, you gain immediately the services of field, staff, and consulting engineers, researchers, chemists, and production personnel . . . *plus* the basic objectivity of an "outside" organization providing individual attention to your individual problems.

What's more, the services of these team specialists are available to you *without actually putting them on your payroll!*

Whether your problem requires boiler or cooling water conditioning, Betz completely-integrated service brings into play techniques, methods, and engineering that can make all the difference in *results*.

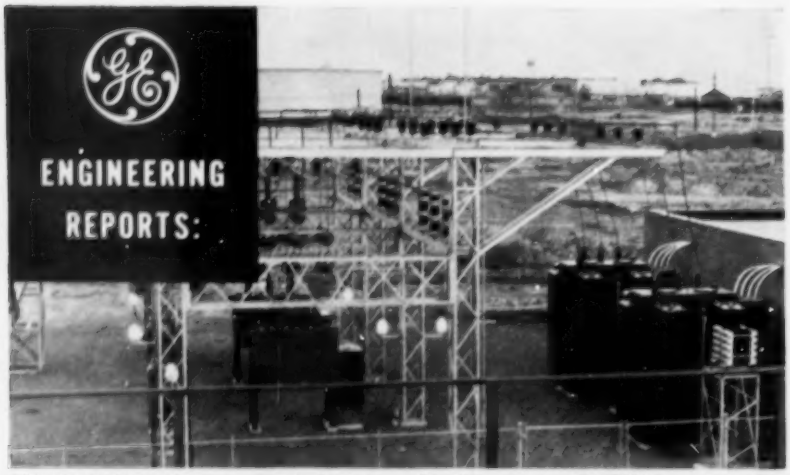
A Betz District Engineer, one of the many important members of the Betz service "team", will be happy to give you the details of our result-getting service. Why not call him in *today?*

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

BETZ

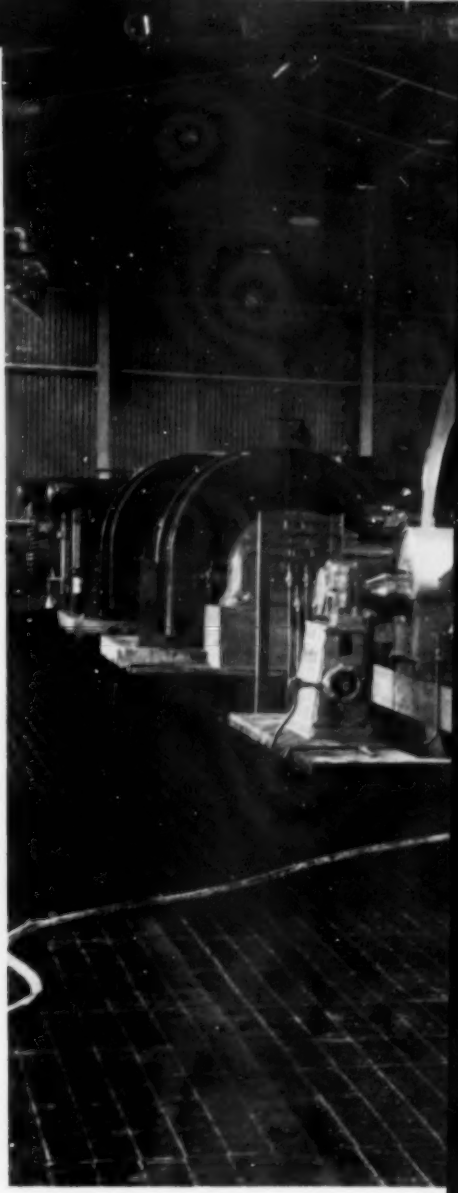
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

ENGINEERING REPORTS:



EASY EXPANSION was provided during planning stages of SOHIO system. For example, each of two 11,500-kva power transformers on General Electric package substation, providing 4160 v for plant distribution, can be uprated to 14,394 kva.

DESIGNED for outdoor process use, two General Electric totally enclosed, inert-gas-filled induction motors, with gas to water heat exchangers, drive centrifugal blowers. Total connected load of the plant's motors approximates 25,000 hp.

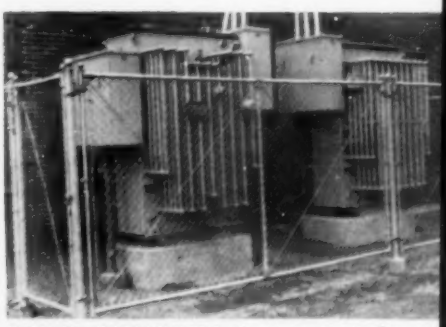


Here's how system

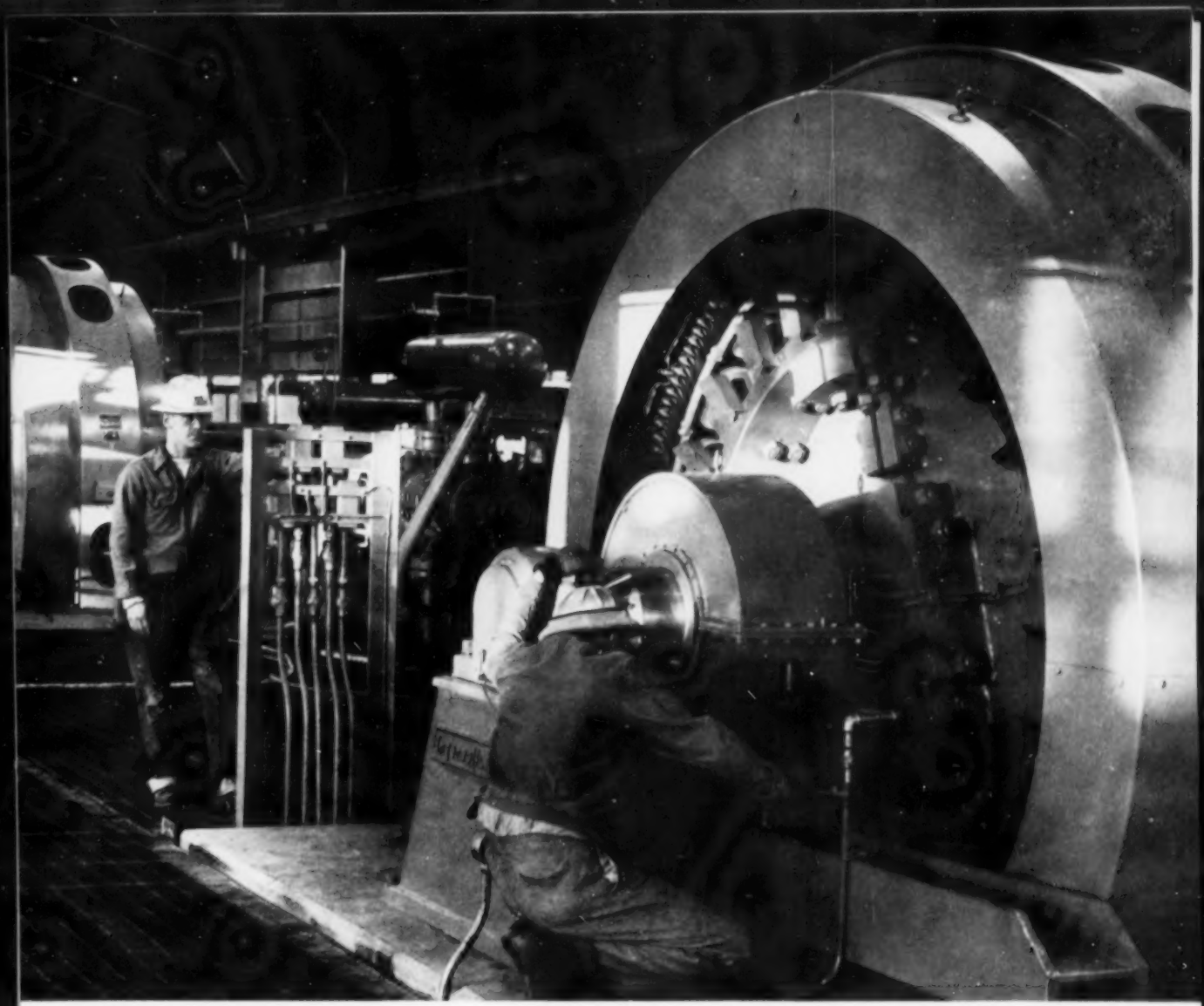
OVER CURRENT and short circuit protection is provided for 175 through 1000-hp motors by 4160-v Limitamp* controllers.

COST SAVING load center system brings higher voltages closer to load. Low voltage switchgear controls auxiliary motors.

*Reg. trade-mark of General Electric



SYSTEM PROTECTION through neutral grounding covers all voltage levels, including 1000-kva medium transformers.



PRESSURIZED HOUSING encloses sliprings of two 3000-hp General Electric synchronous motors driving synthesis gas compressors. Secondary selective system helps permit almost all motors in the system to have a standby power source.

SOHIO Chemical's engineered electrical helps prevent lost production

General Electric engineered system at new Lima, Ohio, petrochemical plant was planned for reliability, future expansion.

The SOHIO Chemical Company operates their new $17,000,000 petrochemical plant with a General Electric engineered electrical system planned and installed to meet present and future electrical requirements. This modern plant, designed to produce 300 tons of anhydrous ammonia per day, was engineered and constructed by The M. W. Kellogg Co., New York.

2 BASIC REQUIREMENTS were set forth by SOHIO . . . (1) reliability to help guard against lost production and (2) flexibility for future expansion. General Electric engineers worked closely with SOHIO personnel and their consultants to gain these objectives. On these pages are some highlights of the system.

WHEN YOU BUILD, or modernize, take advantage of General Electric quality-engineered electrical equipment and complete engineering services for the chemical industry. Your General Electric Apparatus Sales Representatives at the nearest G-E Apparatus Sales Office will give you complete information. Contact him early in your planning and write for bulletin GED-2244 "Engineering Services" to General Electric Co., Section 681-13, Schenectady, New York.

Engineered Electrical Systems for the Petrochemical Industry

GENERAL ELECTRIC

Johns-Manville organizes to give you better insulation service

New and separate insulations division created to provide industry greatly improved Sales and Engineering service to meet modern problems

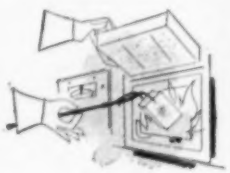
• Johns-Manville is now concentrating all industrial insulation operations within a new, fully integrated insulations division. This greater specialization makes possible the most complete insulation service available to industry. It consists of—

Sales Representatives . . . men on whom you can rely for your insulation recommendations. Your J-M salesman will help you select the insulating material exactly right for your job—the one that will provide maximum fuel savings, improved process control, and minimum maintenance. As co-ordinator of J-M's extensive research-engineering-manufacturing facilities, he offers you outstanding insulation training and experience.

Insulation Engineers—Backing up the J-M salesman on every job is the J-M insulation engineer. He is primarily concerned with solving insulation problems. He recommends the economic thickness of insulation, as well as the proper finishes, weatherproofing and securement. His highly specialized knowledge makes possible an intelligent recognition and handling of your individual insulation requirements.

Insulation Contract Units . . . Fully aware that no insulation is better than the man who applies it, the J-M Insulation Contractor makes care and skill in the scientific application of Johns-Manville insulations his stock in trade. He maintains a complete crew of estimators and mechanics trained in J-M application techniques. He is ready to give you fast, efficient service on any insulation job—large or small. Proud of his reputation for integrity in his own community, the J-M Insulation Contractor merits your complete confidence.

Complete Range of Products—In this day of exacting temperature control, the need for specific insulations for specific services is greater than ever before. Recognizing this, Johns-Manville manufactures insulations for every industrial requirement. Produced from the finest grades of asbestos, magnesium carbonate, diatomaceous silica, refractory clays and ceramic fibers, they are designed to afford maximum insulating effectiveness and durability at operating temperatures ranging from minus 300F to plus 3000F.



Extensive Research Facilities—At Manville, New Jersey, Johns-Manville maintains the world's most completely equipped insulation laboratory. Here insulation scientists are engaged in a continuous program of developing new and better insulating materials. In addition, their technical knowledge is always available to J-M customers whose insulation problems require special study.

Experienced Management—At headquarters as well as in the field, management of the new insulations division consists of men who, in line with J-M's promotion-from-within policy, are insulation veterans. With a realistic grasp of customers' needs, they are alert to new and better ways to serve you . . . now, and in the future.

On Your Next Insulation Job—Whether your next insulation job is big or little, simple or complex, let Johns-Manville handle it for you. Just call your nearest J-M sales office, or write direct to Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario. *Chances are, you'll be glad you did!*

Johns-Manville *first-in* **INSULATION**

MATERIALS · ENGINEERING · APPLICATION

(To obtain more data on advertised products see page 208)

☆

Unit started up immediately . . .

☆

Down only 5 days in 8 months . . .

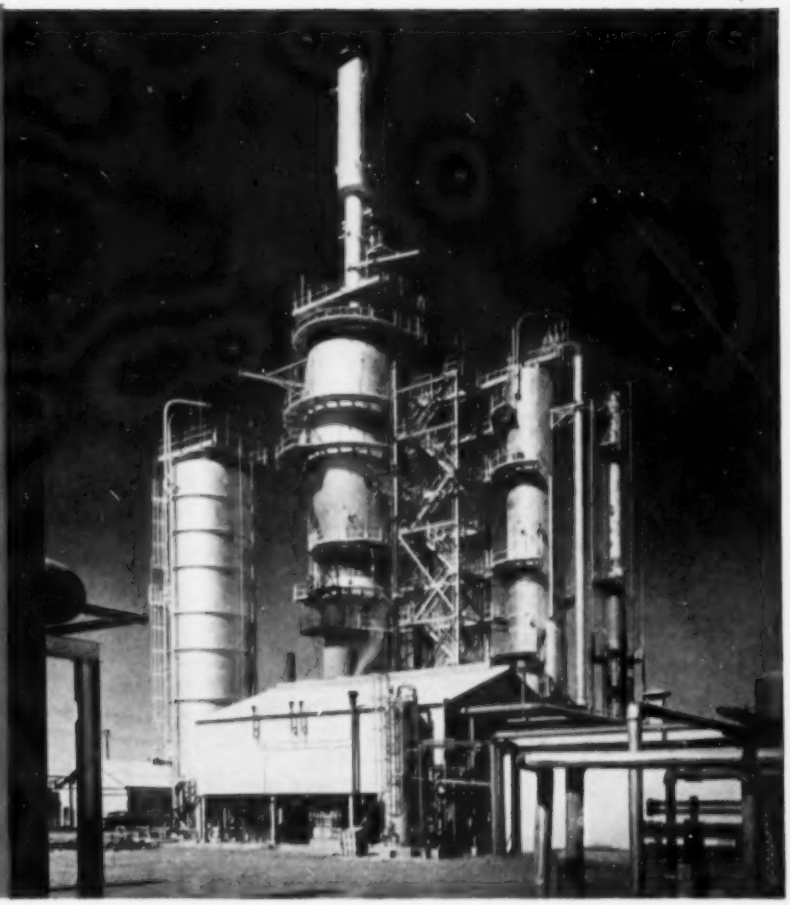
☆

Operating at 79% conversion . . .

☆

Output 10% above design rating . . .

☆



Champlin's Orthoflow* Proves Itself

FLUID CATALYTIC CRACKER

When Champlin Refining Company became part of The Chicago Corporation, up to $10 million was invested in a modernization program to expand capacity and raise octane level of its Enid, Oklahoma refinery. A major factor in minimizing initial cost of these facilities, and getting them on stream quickly and efficiently, was an Orthoflow Fluid Catalytic Cracker. Designed and built by The M. W. Kellogg Company for a fresh feed capacity of 9,000 BPD, and total throughput of 13,500 BPD, this Orthoflow also promises minimum maintenance.

The Orthoflow was erected by M. W. Kellogg well ahead of schedule, and went on stream without trouble immediately on completion. Within a month of initial operation, the unit fulfilled the Kellogg guarantees and was accepted. It operated continuously for 3 months, when repairs on the lube oil pump required a shutdown. This also permitted complete inspection of the interior of the Orthoflow, and reassured Champlin that the unit's lining and general condition were excellent. After 5 days, the unit was back in service, and ran without interruption for 5 months. Total time in service at this writing: 8 months. Total time out: only 5 days! The Orthoflow is now operating at 79% conversion rate, and about 10% above original design capacity.

The Champlin unit is one of seventeen Orthoflow Fluid Cat Crackers engineered or erected by The M. W. Kellogg Company for leading refiners throughout the world, with throughput capacities ranging from 3,500 BPD to 102,000 BPD. The trend toward this vertical-design cat cracker is graphically explained in a full-color, 15-minute animated movie. Refiners interested in seeing this film in their offices can make arrangements by contacting M. W. Kellogg.

*Trademark of The M. W. Kellogg Company

Refinery Process Division

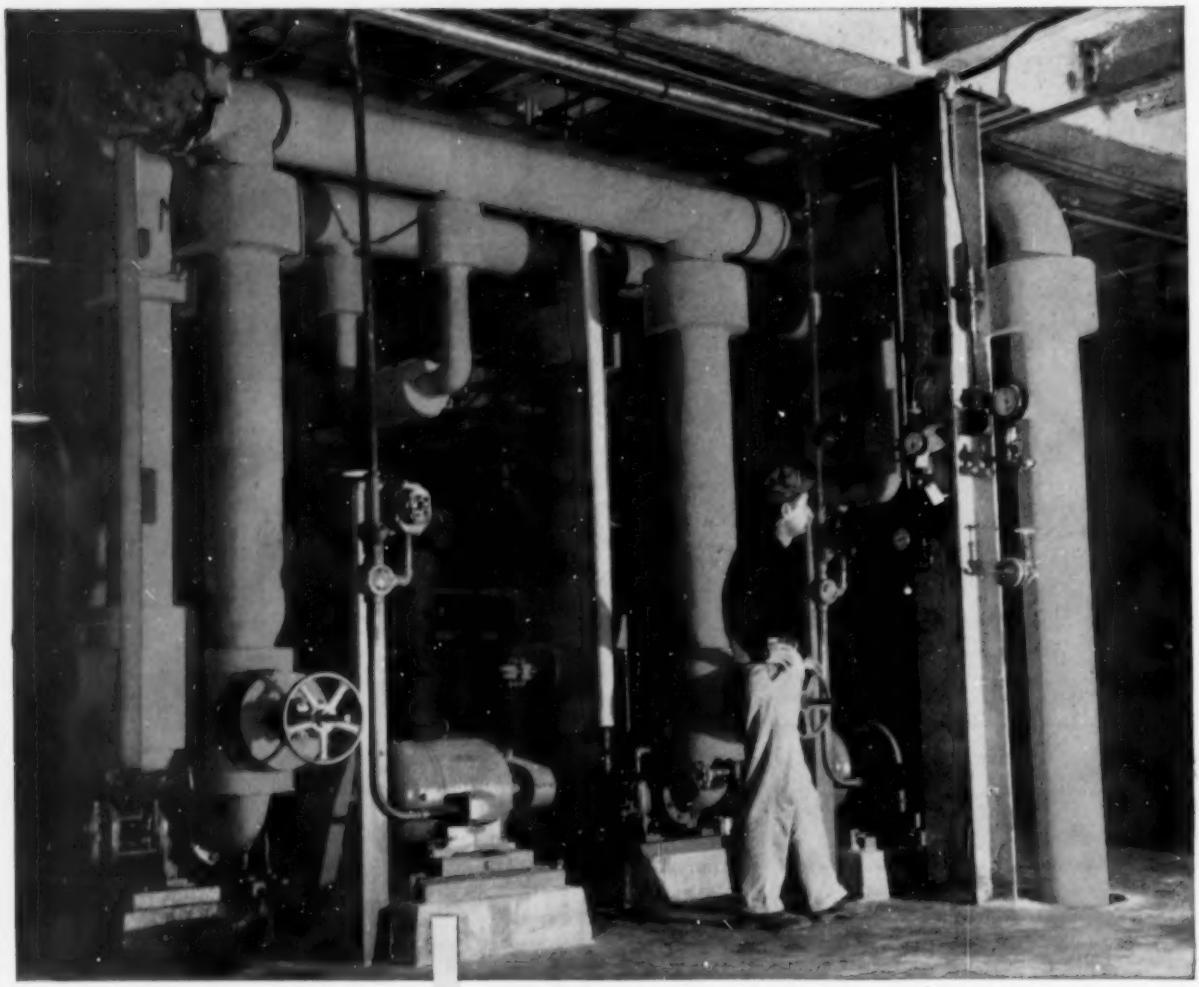
THE M. W. KELLOGG COMPANY

711 Third Avenue, New York 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

M KELLOGG W



Specify gb SNAP*ON *for good and fitting reasons*

Plant piping takes on this trim, tailored look — and in record time — when you insulate with G-B Snap*On, the one-piece molded pipe insulation of fine glass fibers. From ¾" through 33" IPS and in 3' and 6' sections depending on pipe size. With just a pocket knife and a stock of Snap*On in nesting sizes, *anyone* can make easy work of the once-tedious job of insulating bends, valves and other fittings.

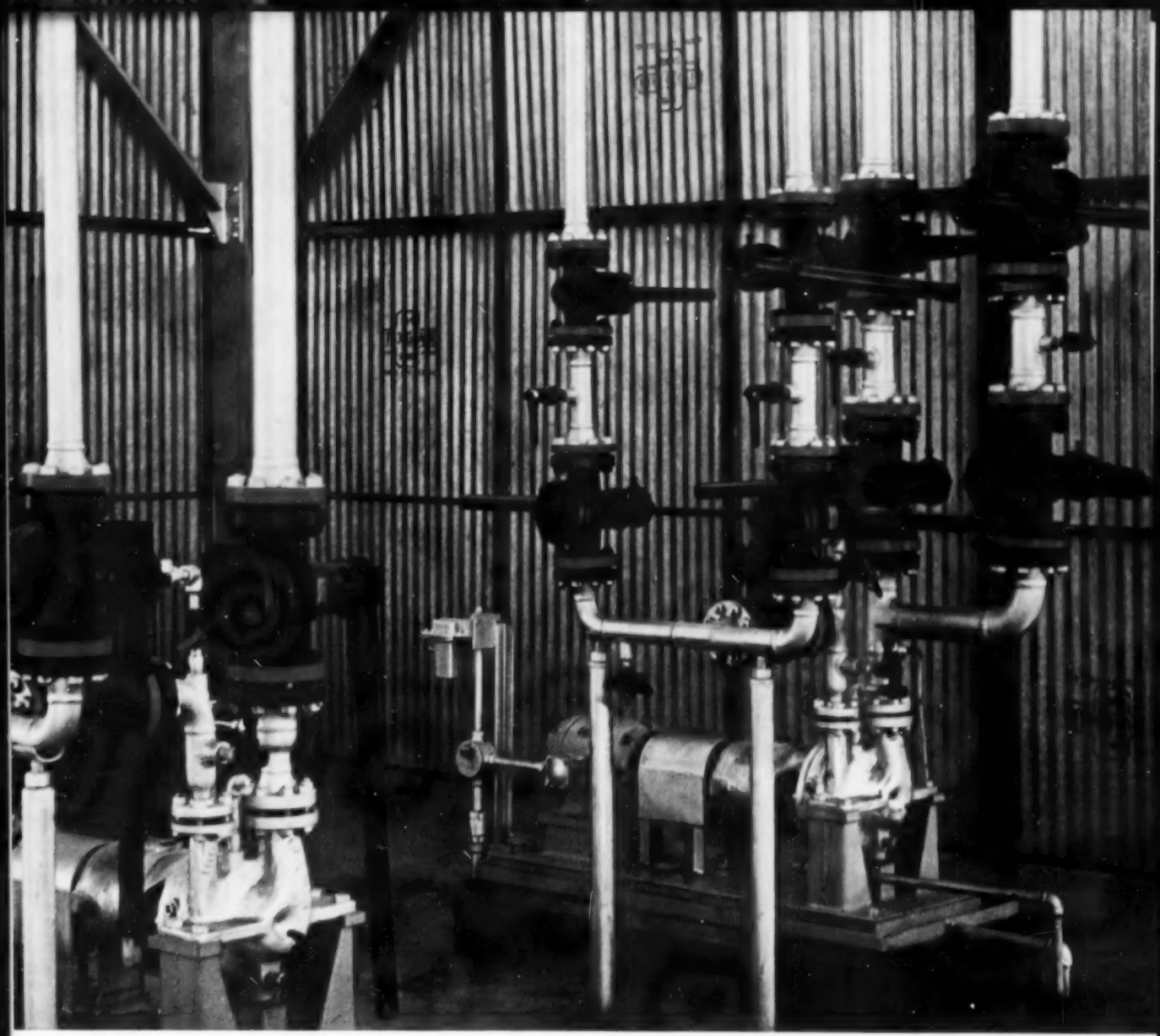
To fully understand why this material saves so much time and money on fittings and straight runs you need only handle a 6-foot section of Snap*On. It's flexible, yet resilient. It's feather-light, yet tough. It's almost impossible to damage, yet easy to cut with a knife. And to these obvious advantages, you can add such unseen benefits as *permanence* and the *highest thermal efficiency of any pipe insulation on the market.*

Next time you have hot or cold piping to insulate, call your nearby distributor, listed in the Yellow Pages under "G-B Insulations." In the meantime, write today for our new 8-page brochure with full details on "the first all-new pipe insulation in 60 years."

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Railroad gaskets and supplies.

266 W. 10th St., Kansas City, Mo.



The "extras" cost no more

When you use Rockwell-Nordstrom valves you get "extras" you can't buy in ordinary valves. Pressurized lubrication in the Sealdport* system assures leakproof sealing (without uncertain "forced" seating), and eliminates costly wearing friction. Because they are rotary plug valves, quarter-turn operation and unexposed seating are two more money saving extras. The cost? Rockwell-Nordstrom valves cost no more to buy (often less) than ordinary valves and cost much less to use.

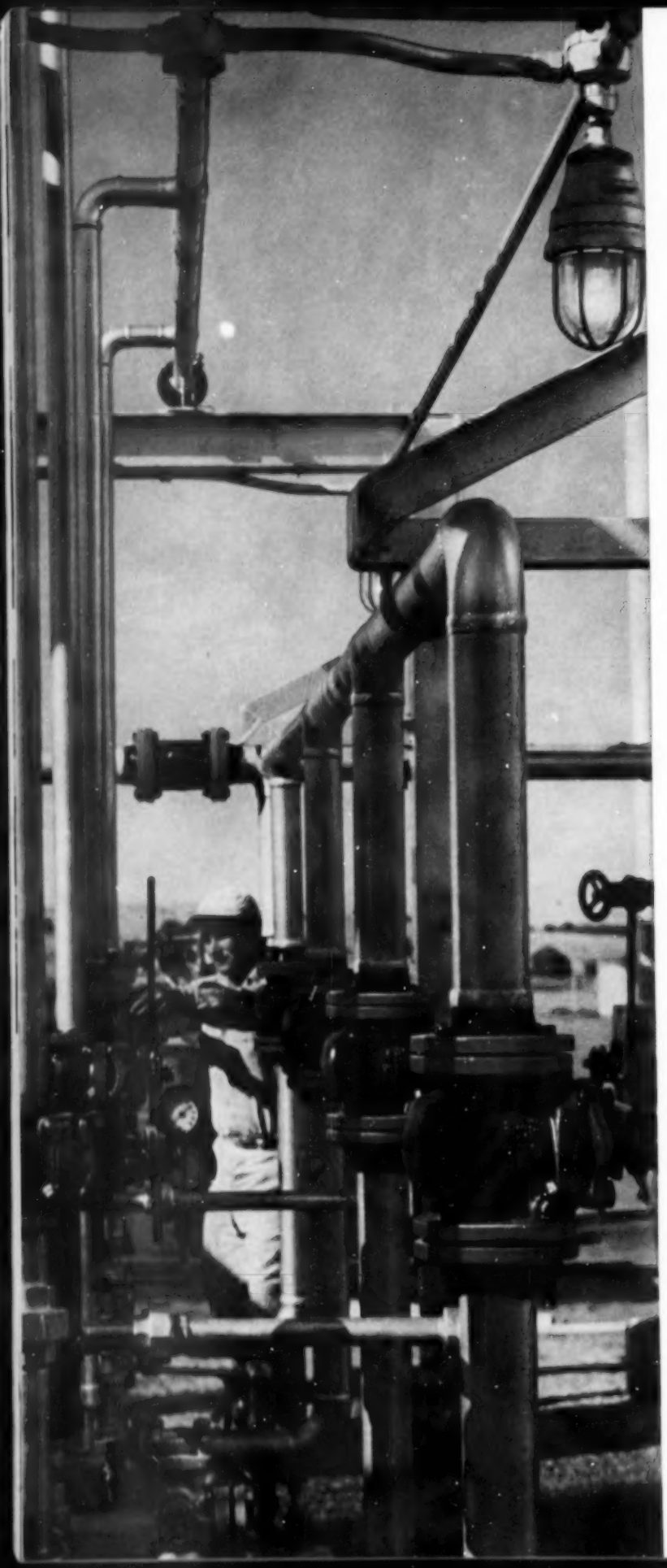
Forty years of lubricated plug valve leadership by the original and world's largest manufacturer is your assurance of economy and trouble-free dependability when you specify Rockwell-Nordstrom valves. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

*A registered trade mark of Rockwell Manufacturing Company.

ROCKWELL-Nordstrom VALVES

Lubricant Sealed for Positive Shut-off

40th Year *of lubricated plug valve leadership*



Complex manifolding made easy

You can use Rockwell-Nordstrom valves in complex manifolds where ordinary valves wouldn't even begin to fit. Because they have no heavy, bulky bonnet cavities or rising parts, Rockwell-Nordstrom valves take little more space than their flange diameters. Additional advantages: positive shut-off prevents product contamination; firmly seated plug and rugged construction prevent shock load failures that are common to ordinary valves on pulsating flow.

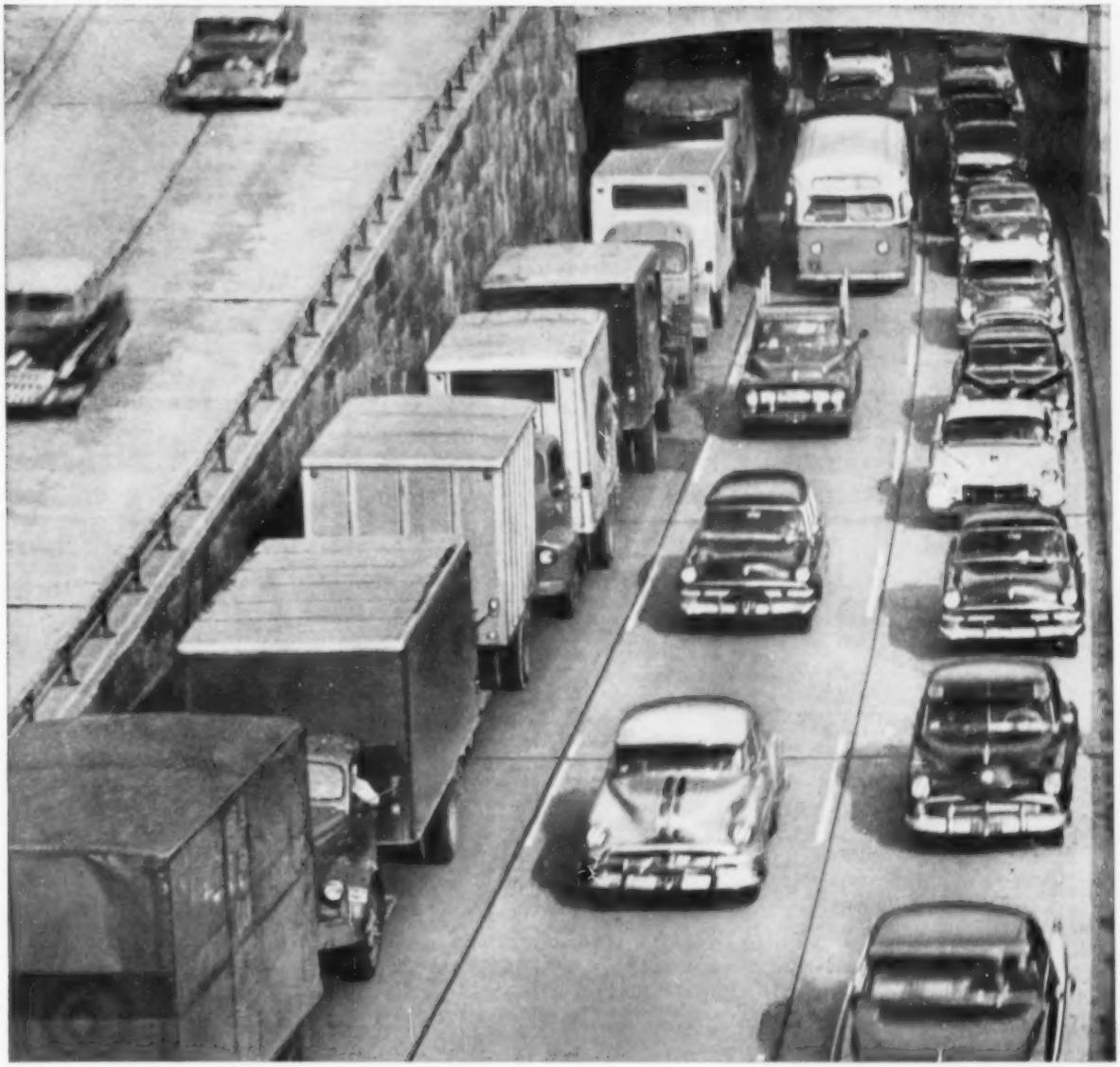
Rockwell-Nordstrom valves cost no more to buy than ordinary valves—and they cost far less to *use*. Available in a complete range of sizes and pressure ratings in semi-steel, steel, stainless and corrosion resisting metals. For details, write: Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

Available at leading suppliers . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed for Positive Shut-off

40th Year
of lubricated plug valve leadership



to meet exacting lubrication standards, specify

ENJAY PARANOX®

detergent-inhibitor additives

Blenders who must meet the rigorous specifications of heavy-duty lubricants can depend on the world-famous Paranox group of detergent-inhibitors for compounding with every type of base stock. Like all the highest-quality additives of Enjay's complete line, the Paranox group was engineered to meet specific performance demands.

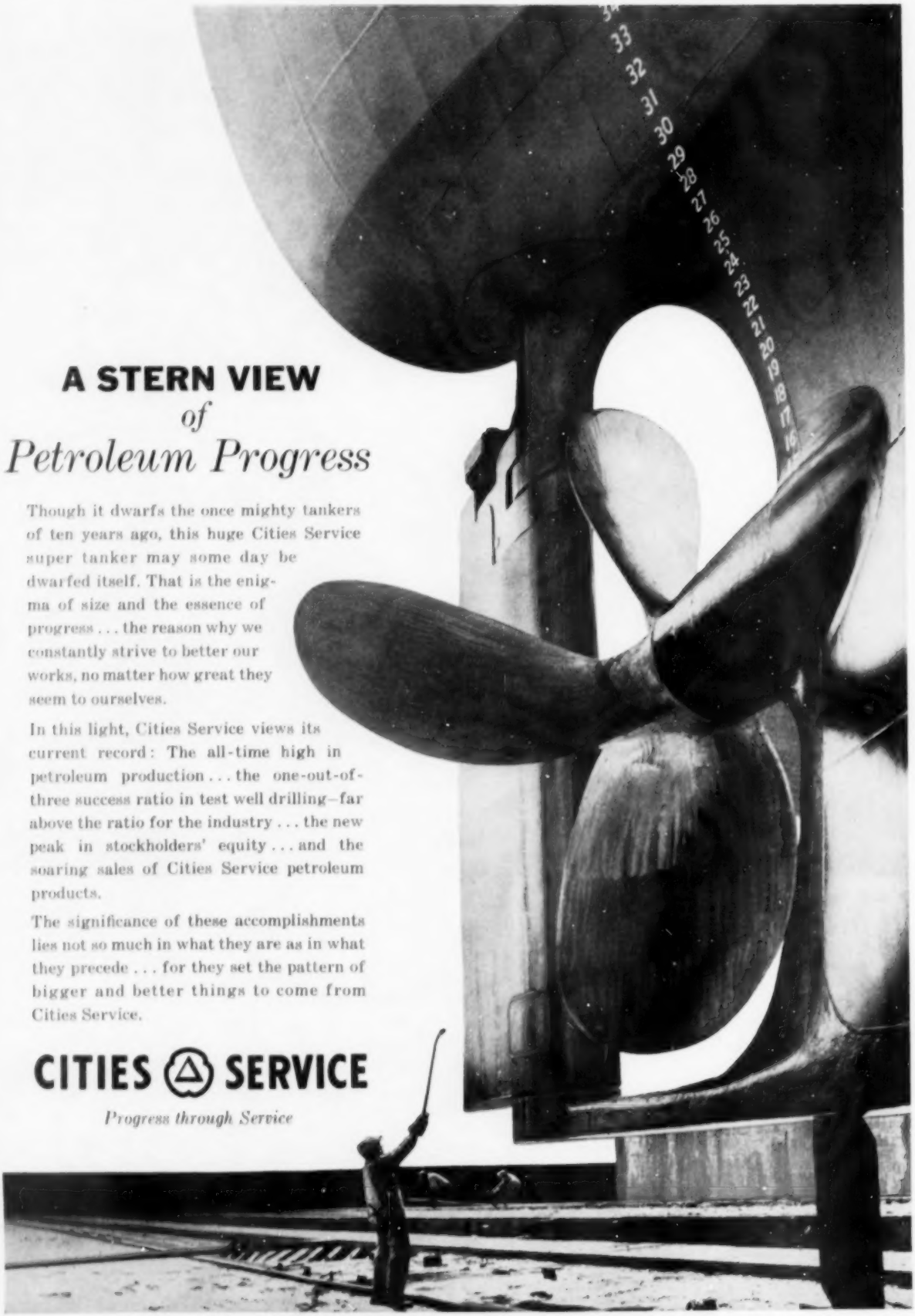
Take advantage of Enjay's many years of experience, working with leading oil companies and engine manufacturers, to develop lubricating oil additive formulations for a wide variety of military and commercial uses.

Write, wire or phone the Enjay Company—your only source for a complete line of additives (Paramins®) for fuels and lubricants.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 WEST 51st STREET, NEW YORK 19, N.Y. • Other offices: Akron, Boston, Chicago, Tulsa



A STERN VIEW
of
Petroleum Progress

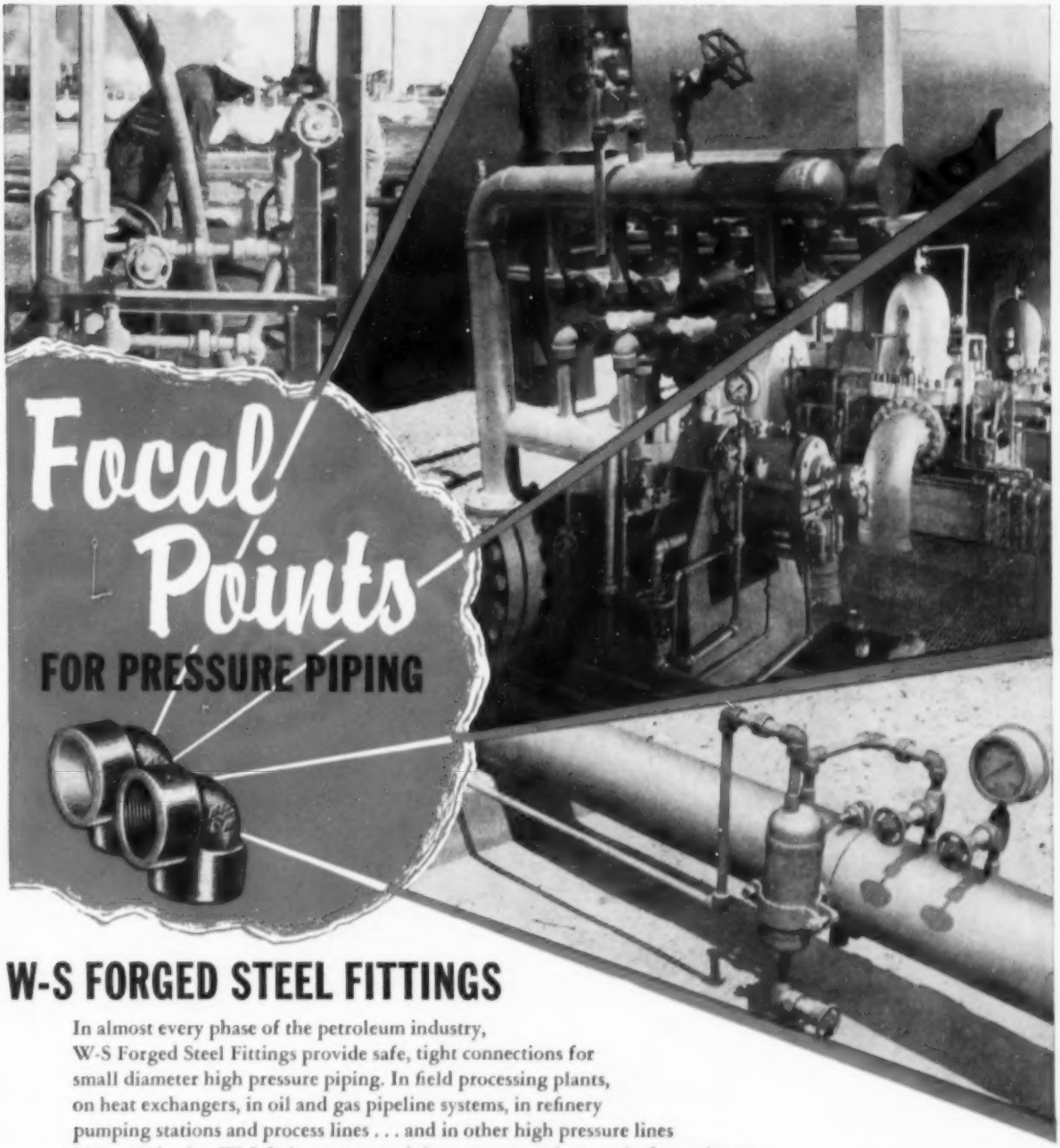
Though it dwarfs the once mighty tankers of ten years ago, this huge Cities Service super tanker may some day be dwarfed itself. That is the enigma of size and the essence of progress . . . the reason why we constantly strive to better our works, no matter how great they seem to ourselves.

In this light, Cities Service views its current record: The all-time high in petroleum production . . . the one-out-of-three success ratio in test well drilling—far above the ratio for the industry . . . the new peak in stockholders' equity . . . and the soaring sales of Cities Service petroleum products.

The significance of these accomplishments lies not so much in what they are as in what they precede . . . for they set the pattern of bigger and better things to come from Cities Service.

CITIES SERVICE

Progress through Service



W-S FORGED STEEL FITTINGS

In almost every phase of the petroleum industry, W-S Forged Steel Fittings provide safe, tight connections for small diameter high pressure piping. In field processing plants, on heat exchangers, in oil and gas pipeline systems, in refinery pumping stations and process lines . . . and in other high pressure lines 1/8" to 4" in size, W-S fittings protect piping systems against costly down time.

They are drop forged from solid bars for extra strength and toughness . . . and they're safety-factor designed.

W-S Forged Steel Fittings are available in screw-end and socket-welding types in carbon, stainless and alloy steels.
For more information send today for our informative catalogs.

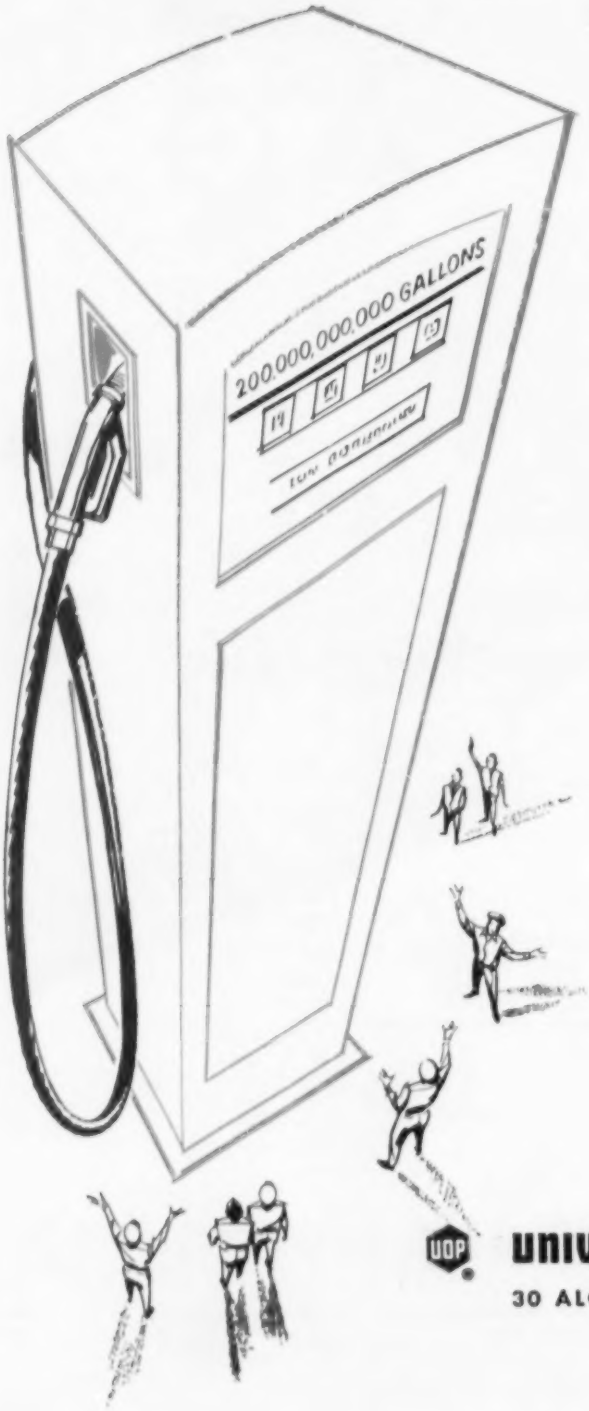
W-S FITTINGS DIVISION

HKP H. K. PORTER COMPANY, INC.
Roselle, New Jersey

 (To obtain more data on advertised products see page 208)

More than 200,000,000,000 GALLONS

OF GASOLINE KEPT GUM-FREE WITH UOP #5 INHIBITOR



Any way you figure it, that's a lot of gasoline . . . convincing proof that the petroleum industry has approved and demanded UOP #5 Inhibitor.

Obviously, there are good, sound reasons for this preference. UOP #5 has demonstrated unexcelled inhibitor potency and versatility. It is the product you can depend on for the really tough stability jobs.

UOP #5 is economical. For any given stability requirement you can't beat #5 on a cents (or fraction thereof) per barrel basis. Remember, five molecules of UOP #5 will protect 1,000,000 molecules of gasoline.

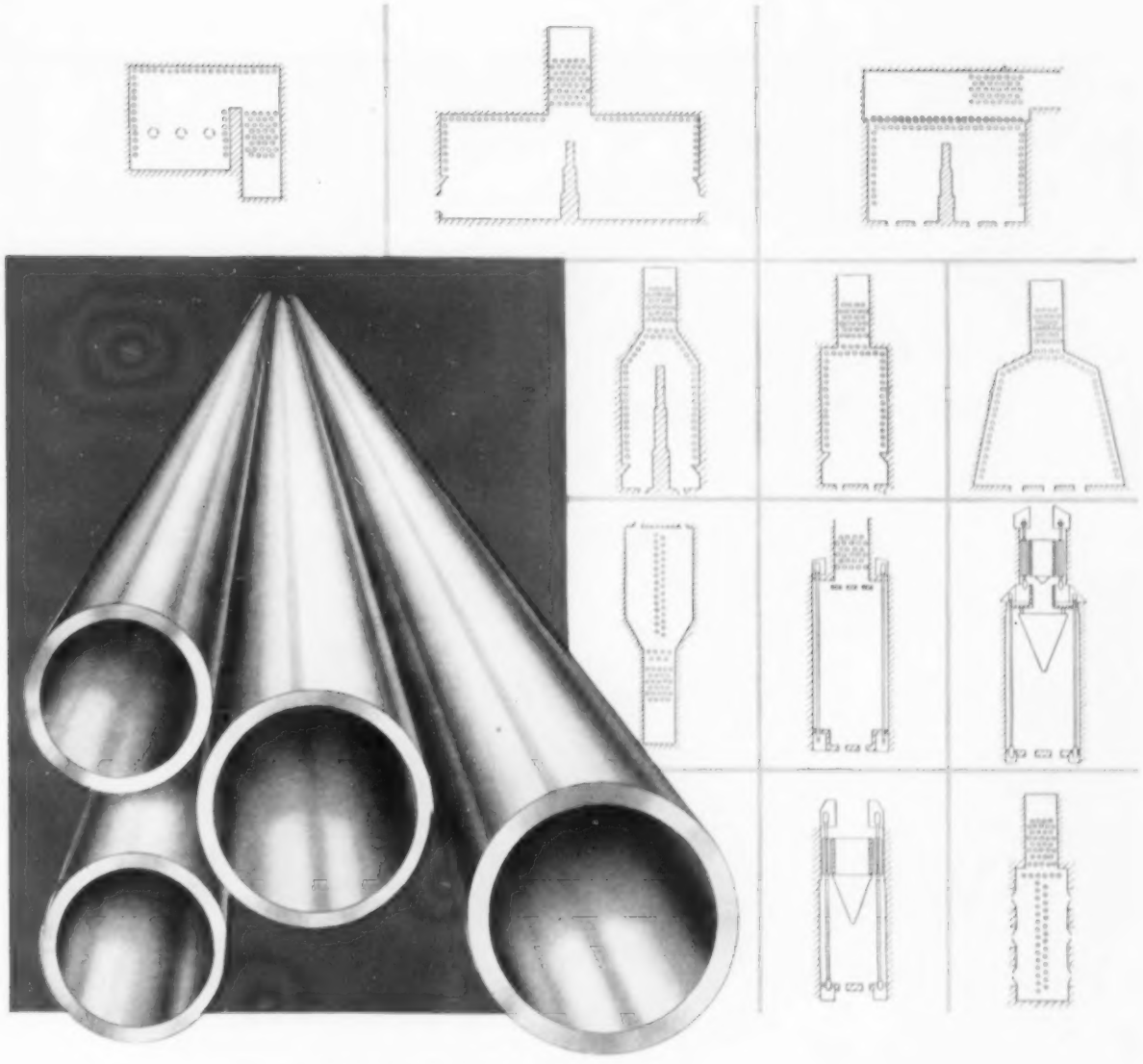
UOP Inhibitor #5 was introduced by Universal during World War II and the techniques of applying it have been effectively developed over the years. This experience is offered to refiners, and our on-the-spot representative will be glad to assist in its application to your products. Just write us.

PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U.S.A.

(To obtain more data on advertised products see page 208)



DESIGN ADDITIONAL SERVICE LIFE
INTO YOUR PROCESS HEATERS

...with B&W TUBING

Long service life of process heater tubing for the oil refining and petrochemical industries dictates selection of a B&W Croloy to insure maximum corrosion and oxidation resistance, and fully satisfactory handling of unusual temperature and pressure conditions which may arise. Mr. Tubes —your friendly link to B&W—has facts and figures to help you choose the best tube for the job. Get in touch with him to discuss your heater tube requirements, for both original equipment and maintenance. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-6062(P)

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless steels

Easy to Mix. Just add water according to instructions. Mixes in about five minutes.

Consistency of Mix is as workable as any cement mix.

Pours Readily into any prefabricated form.

New ALUNDUM* 33-I insulating castable...mixes and pours like concrete...protects to 3300°F.

A New Norton Refractory R_x

Now you can protect critical areas in your furnaces and other high temperature equipment to 3300°F with ALUNDUM 33-I insulating castable — a new, easy-to-install NORTON Refractory Product.

- 33-I comes in dry form in moisture-protective bags.
- 33-I — You just add water according to instructions. Mixes readily.
- 33-I pours into any prefabricated form like a concrete mix.

And . . .

- 33-I insulates up to 3300°F.
- 33-I is light in weight and monolithic in structure.
- 33-I saves down time for repairs.

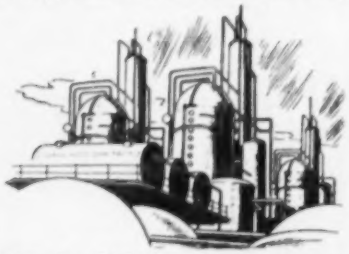
Characteristics of ALUNDUM 33-I

Density	100 lbs. per cu. ft.
Setting up time	
Stiffens	1 hr.
Initial set	4 hrs.
Final set	18-24 hrs.
Chemical Analysis — Al_2O_3	Primarily
SiO_2	< 0.1%
Fe_2O_3	< 0.1%
Maximum hot face temperature	3300°F
Water added per 100 lbs.	Approx. 4¼ gals.
Grain Size	6F

This newest Norton refractory R_x is engineered and prescribed for maximum protection and quick, easy installation in a wide range of uses. For further facts on ALUNDUM 33-I insulating castable, write to NORTON COMPANY, Refractories Division, 268 New Bond Street, Worcester 6, Mass. Canadian Representative: A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

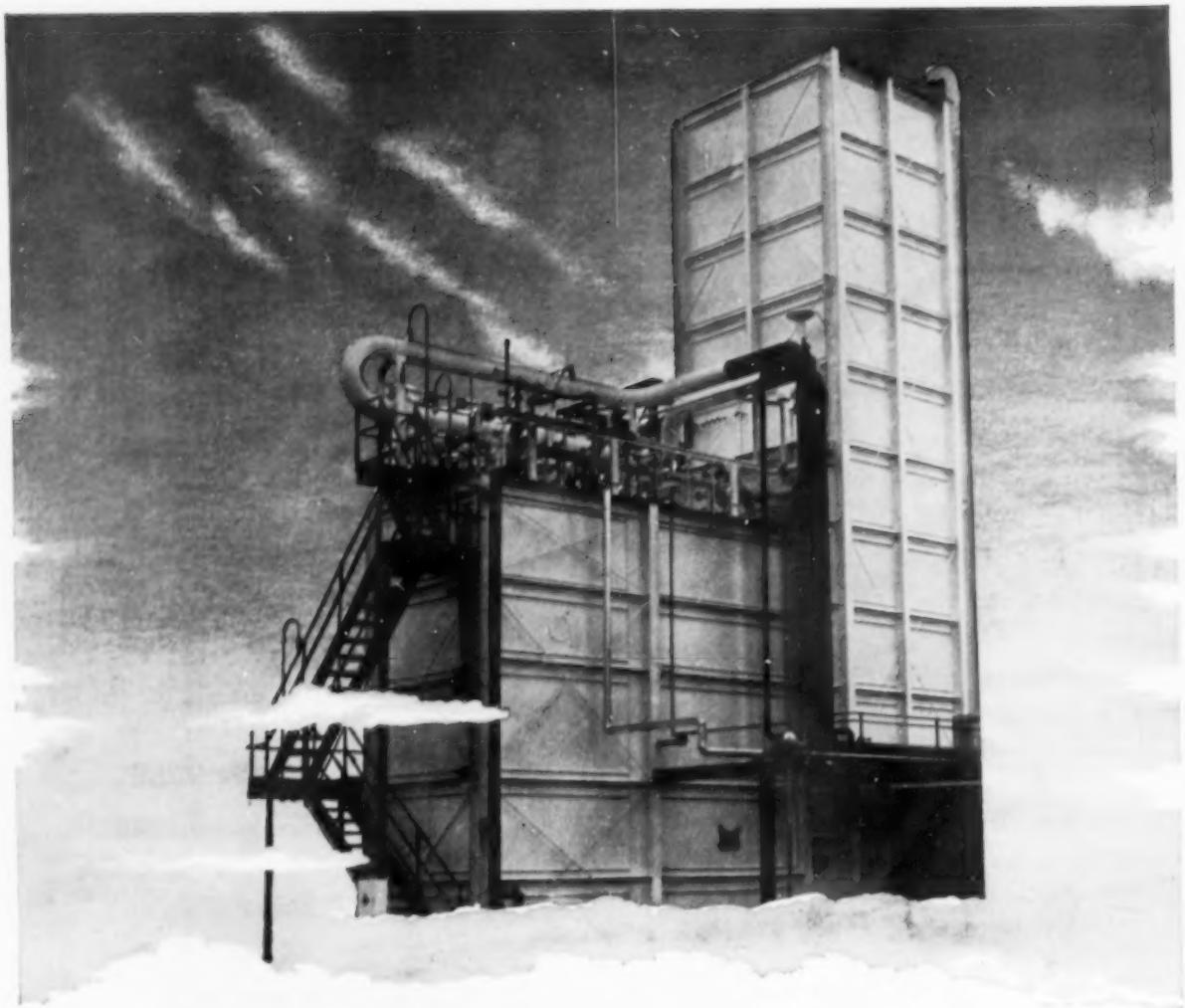
Typical Applications in Chemical Processing



Insulation for high temperature reactors and furnaces.

NORTON
REFRACTORIES
Engineered... R_x ...Prescribed

Making better products...
to make your products better



This plant's stockpile is worth millions--

yet it doesn't cost a cent!

The "wild blue yonder"—the free and limitless atmosphere—is the stockpile for Air Products Oxygen (and/or Nitrogen) Generators. There are no delivery problems for this inexhaustible raw material. There are no price fluctuations and no shortages to trouble the owners of these plants.

The method is basic. The production of oxygen and nitrogen from air is accomplished by "Low-Temperature Processing". The air is liquefied by refrigeration and the nitrogen is drawn off at its boiling point (fractional distillation) leaving the pure oxygen product.
Your own "On-Location" Generator can provide you with a continuous supply of oxygen regardless of your requirements—including moderate to large tonnage users. We will furnish and install a complete facility at no capital investment on your part—on a lease basis including a purchase option. If you prefer, we will operate and maintain the facility and guarantee your oxygen savings.

Send us details regarding your requirements and expected future needs. We will then give you a realistic estimate of the savings you can expect with an Air Products Generator installed in your plant.

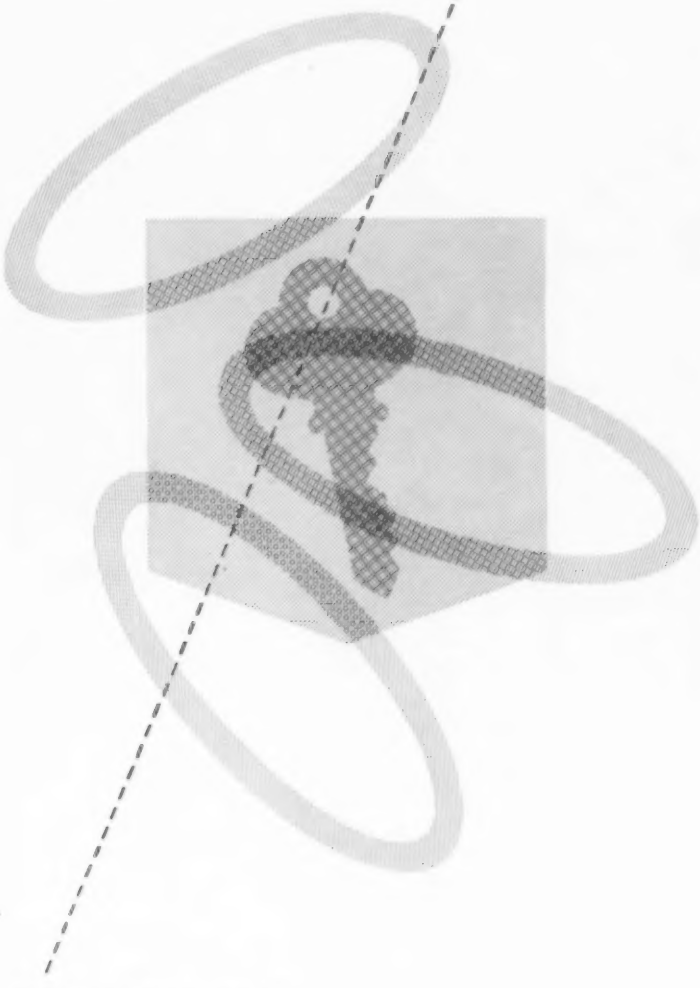
LOW COST
OXYGEN-NITROGEN

Air Products
INCORPORATED
Dept. I, Box 538, Allentown, Pa.

More than 800
successful installations

(To obtain more data on advertised products see page 208)

One Furfural Unit Refines All 3



- **LUBE OIL**
- **GAS OIL**
- **CYCLE STOCK**

Furfural has gained widespread recognition as a selective solvent in processing lube oil, and now is used to treat both virgin gas oil and cat cracker cycle oil. One of the outstanding features is that a furfural unit can be used alternately for refining lube, gas oil and cycle stock. Three companies are already using their furfural units for treating both lube oil and cycle stock; forty-two other users of furfural in the petroleum industry can do the same.

In refining middle distillates, furfural treatment improves product quality and increases cracker through-put. Furfural removes unstable materials that form coke, reduces sulfur content, and separates heavy metal complexes.

The same combination of basic properties and attractive economics which have made QO furfural so successful in refining lube oil applies with equal force to these newer applications. QO furfural offers sharp selectivity, ease of recovery, low cost, ready availability and freedom from excessive toxicity.

Write for our Bulletin 203-A "Physical Data on QO Furfural."

The Quaker Oats Company
CHEMICALS QO CHEMICALS DEPARTMENT

339D The Merchandise Mart,
Chicago 54, Illinois

ROOM 539D, 120 Wall St.,
New York 5, N. Y.

Room 439D, Main P. O. Box 4376,
Portland 8, Oregon

In the United Kingdom:
Imperial Chemical Industries, Ltd., Billingham, England

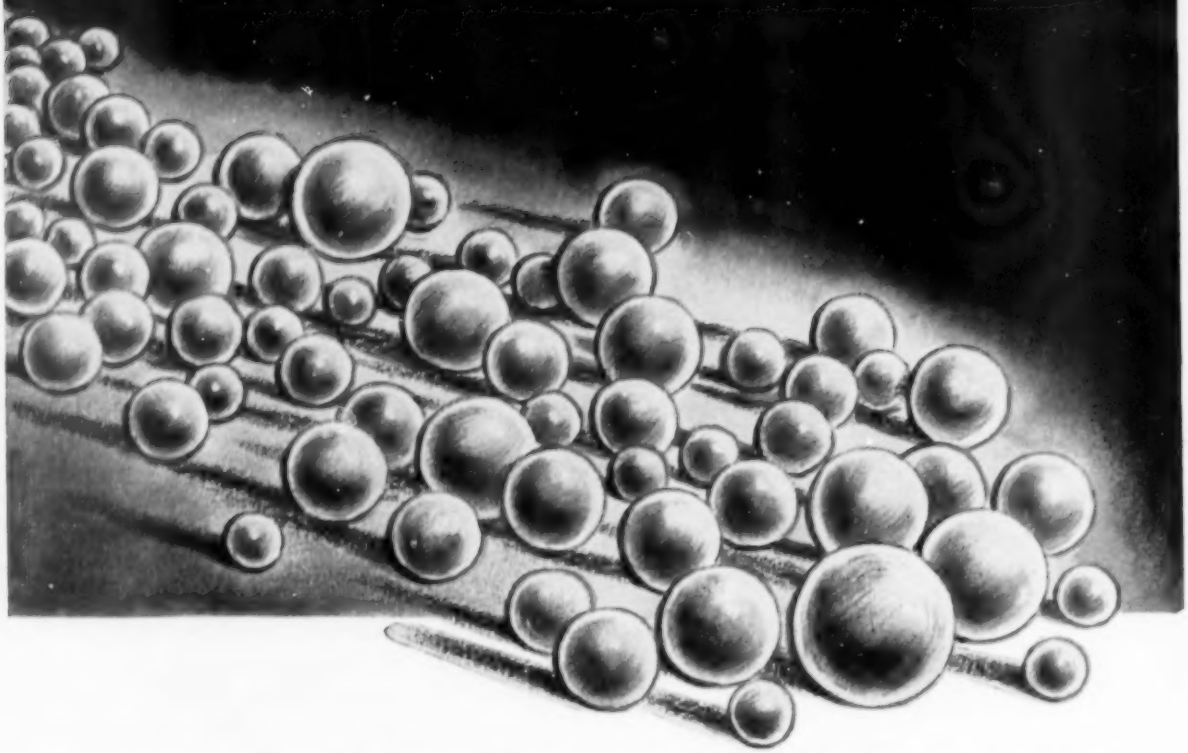
In Europe:
Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands;
Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France;
A/S "Ota", Copenhagen, S. Denmark

In Australia:
Swift & Company, Pty., Ltd., Sydney

In Japan:
F. Kanematsu & Company, Ltd., Tokyo

Ceramic Balls

FOR CATALYST SUPPORT, FOR PYROLYTIC REACTIONS AND AS MOVING BED HEAT TRANSFER MEDIA



As a heat transfer and catalyst support medium in various platinum catalyzed refining operations, "U.S." Ceramic Balls are proving unusually effective. They are being widely used for desulfurization processes and thermal cracking in fixed position or moving bed heaters.

"U.S." Ceramic Balls possess heat-shock resistance, superior thermal conductivity and high specific heat. Resistance to crushing is excellent, permitting successful operation with bed depths exceeding 50 feet. The material is thoroughly vitrified and is particularly recommended for its proven resistance to erosion and abrasion. Their complete chemical inertness makes them exceptionally useful where highly sensitive catalysts are involved.

The smooth surface and spherical shape of "U.S." Ceramic Balls have proven more efficient than irregularly sized and shaped heat transfer elements.

"U.S." Balls are available in two grades, both offering lower cost per unit volume: "Standard Body 57," and "Ceratherm-550" where unusual thermal-shock and heat resistance are required.

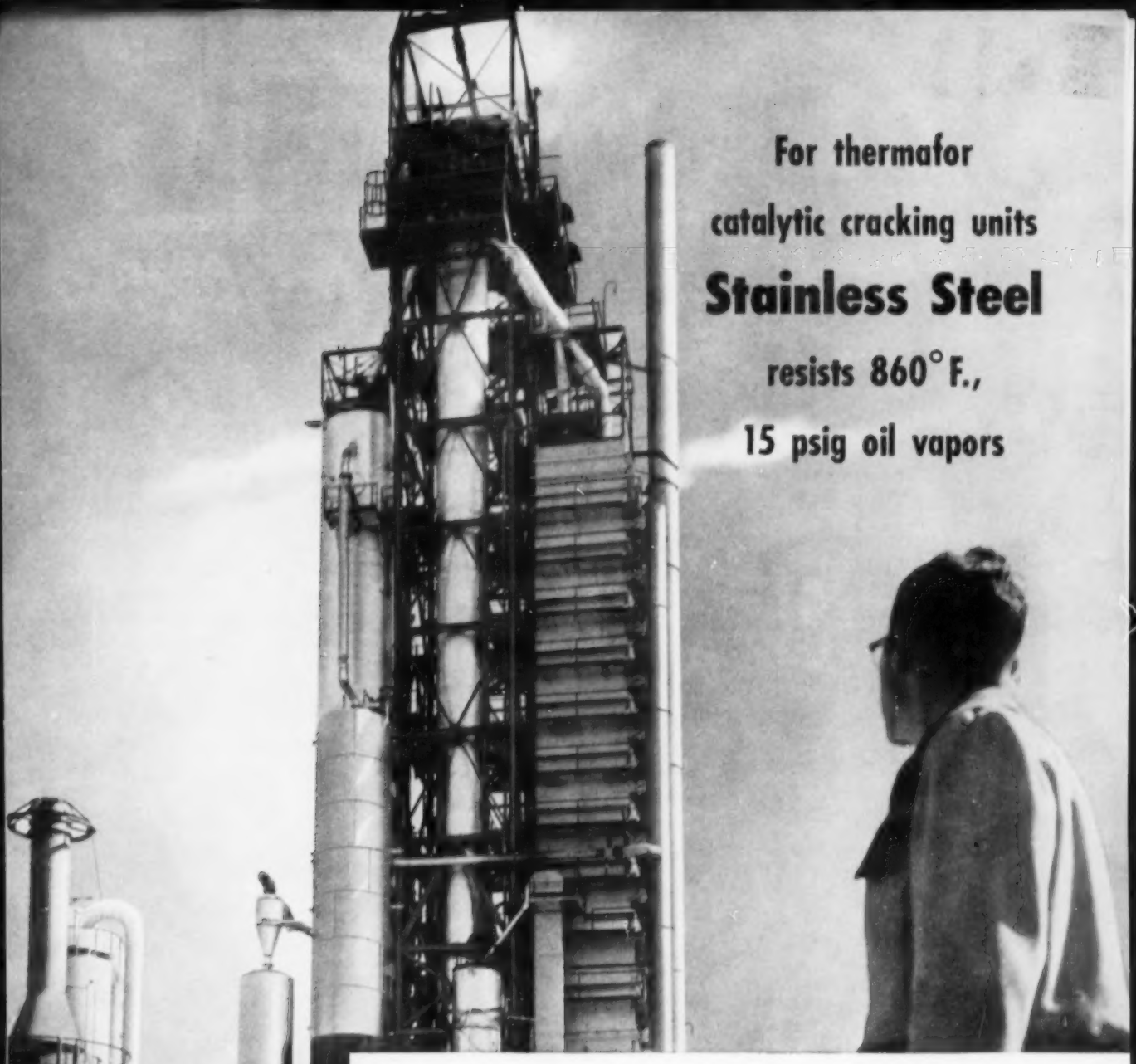
All sizes are available from ¼" O.D. to 3" O.D.

Chemical Ceramics Division

U. S. STONEWARE

AKRON 9, OHIO

3268



For thermafor catalytic cracking units

Stainless Steel

resists 860° F., 15 psig oil vapors

How different refineries would be without Stainless Steel! And how much *more* they would cost to operate! Almost every time you find a high temperature, corrosive situation, you find lots of Stainless Steel.

In the unit shown here, the reactor chamber is lined with 7/64" type 410 Stainless. Reactor internals, bubble caps and trays and various vessel linings are also made from Stainless Steel. These are decisive steps to reduce the continuing high cost of refinery plant corrosion.

When *buying* Stainless Steel, remember that United States Steel offers the widest range of sizes, grades and types. Selection is easy, and you can be sure of service-tested USS quality.

El Dorado, Arkansas refinery of Lion Oil Company, a division of Monsanto Chemical Company.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · PIPE · TUBES · WIRE
BARS · BILLETS · SPECIAL SECTIONS

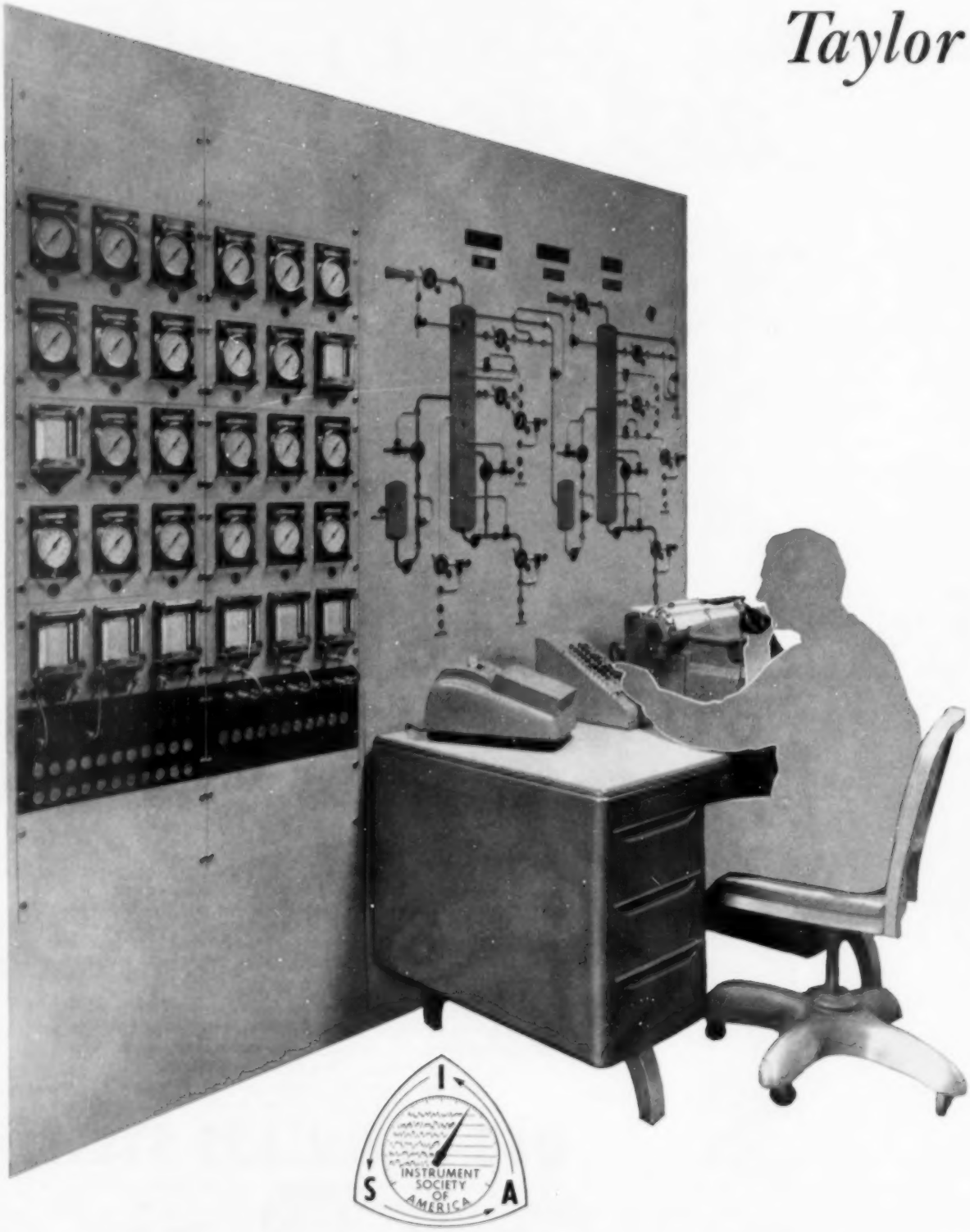
USS

6-805

UNITED STATES STEEL

BIGGEST NEWS

Taylor



AT THE I.S.A. SHOW

Trans-Scan-Log Control System!

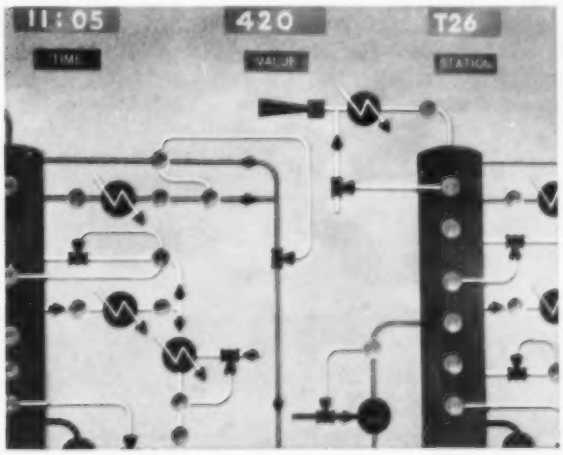
MAKE the Taylor booths your headquarters for scanning and logging at this year's ISA Show. You will see an actual working model of the TSL System . . . the soundest and the most logical integration of process control with process scanning and logging yet devised . . . *a boon to advanced systems engineering.*

The Taylor system goes far beyond today's practices. It is, in essence, a very compact intelligence center which coordinates all related process data, enabling the operator to instantly visualize, evaluate and act upon every processing irregularity as it occurs—without leaving his desk in front of the panel. In addition, it employs the most modern techniques in scanning and logging. Thus the project engineer can observe the entire plant operation more efficiently than ever before.

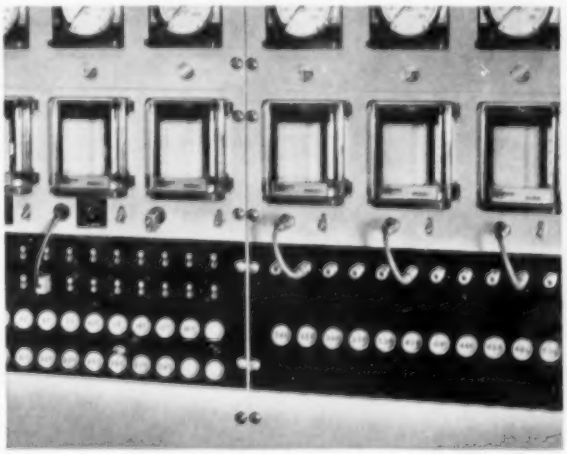
As well as furthering automation in plant operation, the TSL System is a research tool in collecting data on existing units. It can provide accounting or marketing departments with production data as it is accumulated, either on punch cards or tape.

The complete system takes approximately 60% of the space normally required by a standard graphic panel *without* scanning and logging. Because of this compactness one operator can identify and correct any off-normal condition, as well as having a continuous trend record. It is highly dependable, because the Taylor system makes it possible to use simpler, less expensive units.

Nearly two hundred process engineers from all over the country have already visited Rochester to see this advanced equipment demonstrated. If you are unable to visit the ISA Show your Taylor Field Engineer will be glad to make the necessary arrangements for you to see the TLS system in operation. Meanwhile, write for **Bulletin 98268.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.



Graphic Panel—A normal 20-foot graphic panel can easily be compressed into a 5-foot section because space is not required for receivers. Flow lines and symbols can be modified quite simply for process changes. Station identifications are illuminated, also digital readout of time, value and station for on-demand or off-normal. (Off-normal alarm also audible). Point scanning is continuous at the rate of one per second. Scheduled point logging can be set as required.



Process Control Panel—Note plug-in TRANSET* pneumatic control stations, complete with automatic to manual switching. Recorders and indicators are easily interchangeable. All internal connections are completed, ready for field hook-up. Station identification lights give visual tie-in with graphic panel. Convenient electrical and pneumatic plug jacks are provided to record trends of any non-controlled variables.

*Reg. U. S. Pat. Off.

Taylor Instruments MEAN ACCURACY FIRST

GET THE BEST SOLUTION TO ANY TEMPERATURE

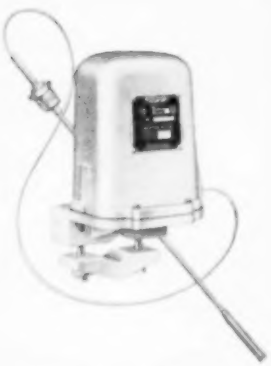
with Foxboro

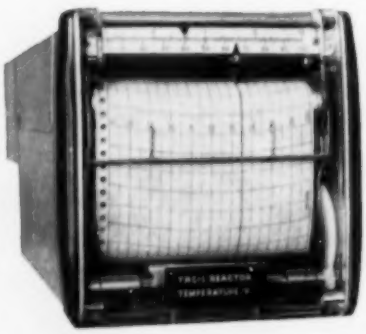
Dynalog Electronic Instruments

Complete line of indicators, recorders, and controllers employing the advanced Dynalog measuring system in which a friction-free air capacitor replaces conventional slide-wire — provides continuous, stepless balancing action. Dynalog Instruments provide up to six records on a single round chart. For use with resistance or voltage type primary elements — pneumatic or electric control action.

Multi-Record Dynalog

- 6 color-coded temperature records on one round chart.
- Each record line a distinctive, non-smudging color.
- No slidewire — no batteries — no standardizing.
- Thermocouple or resistance bulb types.





Consotrol Recording Control Station

One of the complete Consotrol line of compact panel indicators, recorders, and controllers. This advanced control station features full 4" chart and scales, six-months' ink supply, bumpless auto.-man. transfers. The M/58 Consotrol Controller, shown here integrally mounted, provides:

- All four control actions, with two reset ranges, easily adjustable to widest variations in operating conditions.
- Easy lever-setting proportional band, calibrated to 500%.
- High sensitivity and precision due to unique "floating disc" balancing action — even at widest settings of proportional band.
- Interchangeable "plug-in" components.
- Continuously variable reset resistance gives 500:1 rangeability.

PRIMARY ELEMENTS

A complete selection of primary elements for filled thermal systems, resistance bulbs, and thermocouples. Besides standard and thermocouple types, special elements and accessories are available to meet the requirements of virtually any industrial application.

Dynatherm Resistance Bulb

For use with Dynalog Electronic Instruments.

- Superior measurement performance for temperature up to 600°F.
- Fastest response due to positive metal-to-metal end contact with standard wells or sockets.
- Highest sustained accuracy. Permits use of extra-narrow scales — ideal for precise temperature difference measurements.

Roll Surface Temperature Element

- Continuous, automatic measurement or control of roll surface temperatures up to 450°F.
- Extra-rugged construction — with a "feather" touch. Won't mark or score the roll.
- Eliminates friction, radiation, and convection errors.
- Simplest, most accurate way to measure roll surface temperatures.

PROBLEM | from −450°F to +2800°F

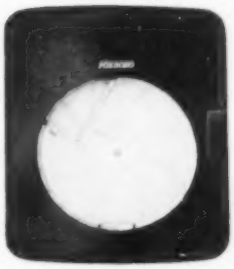
Instrumentation

Model 12A Temperature Pneumatic Transmitter

- Simple way to measure remote temperatures in the −100°F to +1000°F range. Operating spans of 50°, 100°, 200°, and 400°F.
- Compensated for ambient temperatures and pressures.
- Compact, easily installed. Uses regular ¼" O.D. tubing transmission lines — no troublesome conduits, no costly capillary tubing.
- Suitable for any hazardous, corrosive, or outdoor location.

Whenever you have a temperature problem in the −450°F to +2800°F range, you can depend on Foxboro Instrumentation for the best solution. Foxboro's outstanding combination of truly advanced instruments and unequaled experience in applying them, has successfully solved temperature problems as widely different as helium liquefaction and jet engine testing. Foxboro offers a wide variety of primary elements, transmission devices, indicators, recorders, and controllers. Whether a single instrument or a combination is required — filled-system, electronic, or electric — you can be sure of fitting the process *exactly*. Unique Foxboro developments, such as Dynalog* Electronic Instruments, Dynatherm** Resistance Bulbs, and the 12A Temperature Transmitter, continually maintain control standards in step with every advance of modern processing. A few of the instruments which typify Foxboro's better-engineering are shown on these pages. Chart below shows complete temperature ranges covered by Foxboro measuring systems. Write for complete details. **The Foxboro Company, 919 Neponset Ave., Foxboro, Mass.**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND



Electric Proportional Action Controller

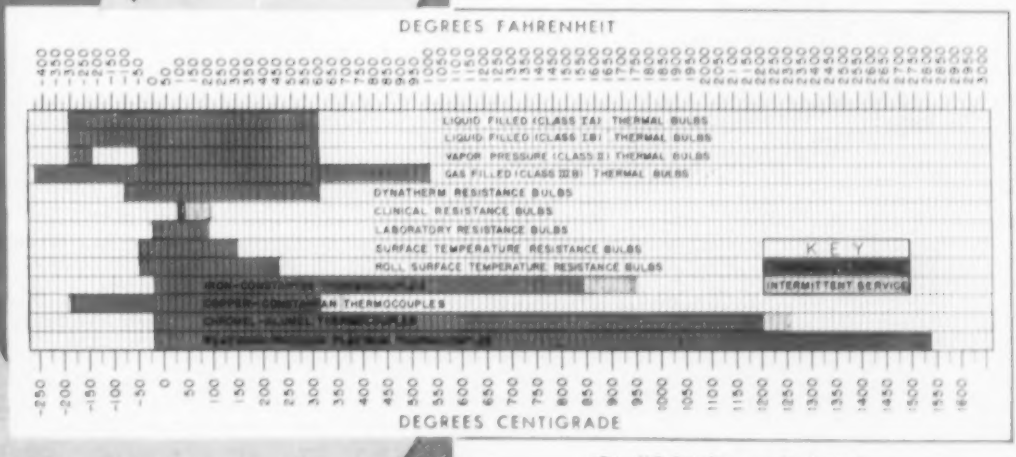
- Can be used with any Foxboro measuring system — mechanical or electrical.
- Precise, frictionless control action through electronic relay and electric valve operator.
- 3 types of proportional control action available.
- Setting knob permits easy, stepless adjustment of control band throughout range of instrument.

FOXBORO

Reg. U.S. Pat. Off.

TEMPERATURE measurement and control

Locate your problem temperature in this table



*Reg. U.S. Pat. Off. **Trademark

EXTRUD-A-FLOW method is as MODERN as AUTOMATION

The EXTRUD-A-FLOW method of Refractory Castable placement is the new and modern method of easy-batching and speedy-conveying of materials on the job site. With the EXTRUD-A-FLOW method, the Refractory materials are extruded in a uniform column, by pressure, from a sealed mixing chamber to the area of application.

FOR REFINERY APPLICATIONS

Any type Refractory Castable required to line refinery vessels—cyclones, cracking units, reforming units, oil stills, boilers and heaters—may be applied by extruding, spraying, casting or troweling.

BALANCED MIX + METERED WATER + THOROUGH MIXING + SEALED CHAMBER (NO CONTAMINATION) + PRESSURE CONTROL = SMOOTH and COMPACT FLOW

For the full story of Speed, Economy and Quality resulting from EXTRUD-A-FLOW placement, write for illustrated booklet. ▶

114

MEXICO REFRACTORIES COMPANY
MEXICO, MISSOURI
NILES FIRE BRICK DIV.—Niles, Ohio ● NATIONAL REFRACTORIES DIV.—Philadelphia, Pa. ● BIG SAVAGE REFRACTORIES DIV.—Frostburg, Md.
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PETROLEUM CHEMICALS DIVISION
NEWS

September ★ One of a Series of Bulletins for the Petroleum Industry ★ 1956

Question Box

1. ARE YOU RECEIVING shipment of additives in drums in less than carload lots?
   If so, you will certainly want to read about the four-figure savings you can realize by simply revising your ordering schedule. See article at right.
2. HOW MANY different economy-grade diesel fuel problems can you lick with a single additive?
   In the article below, you may be surprised at how much one additive can accomplish for you.
3. WHO at the Du Pont Petroleum Laboratory can help you make the most efficient use of gasoline additives?
   Read about him on the next page.
4. HAVE YOU called in a doctor recently—for helping your TEL blending personnel maintain their high standards of *safe* living?
   You can find out about this unique Du Pont medical service on the next page.

To help you overcome economy diesel fuel problems

Has the growing demand for economy diesel fuels created new problems for you? Three of the most common problems encountered by refiners are:

1. Incompatibility
2. Instability
3. Sparking tendency

Du Pont Fuel Oil Additive No. 2 (FOA-2) offers you a solution to all three.

It can help you gain the needed refining flexibility by making it possible for you to blend catalytic-cracked stocks with straight-run products, and overcome the incompatibility problem.

Stabilizer and dispersant

In actual railroad service, the stabilizing and dispersant action of FOA-2 has proved highly effective for reducing the tendency of many economy-grade diesel fuels to cause filter-plugging and injector-sticking.

How much can you save by ordering Du Pont additives in tank-car lots?

Refiners can save considerable money by ordering Du Pont additives in tank-car lots. For example, 4,000 gallons delivered in a tank car, rather than in drums in less than carload lots, will save the refiner between $1,680 and $2,400, as shown in this table:

ADDITIVES	GULF COAST		MID-CONTINENT		WEST COAST	
	$ Saving	% Saving	$ Saving	% Saving	$ Saving	% Saving
Du Pont Antioxidant No. 22	$2,250	6.7%	$2,250	6.7%	$2,400	7.0%
Du Pont Fuel Oil Additive No. 2	$1,680	8.3%	$1,710	8.4%	$1,850	8.9%
Du Pont Lube Oil Additives	$1,830	12.0%	$1,860	12.0%	$2,000	12.5%

Because of the difference in freight rates, the actual dollar savings vary according to the location of the refinery receiving shipment. But no matter where your refinery is located, you will find the savings decidedly worthwhile.

How much can YOU save?

To give you the exact figures, one of our nearby representatives

OVER

Locomotive sparking, a problem which is sometimes accentuated with economy fuels, results from the formation of carbon deposits – generally during idling or while coasting downhill. The ejection of these deposits when glowing, and the resulting fire hazard, may occur during runs under heavy load.

A metallic additive is likely to aggravate this situation by increasing the size and cohesiveness of the carbon deposit particles. Field tests show, however, that an *ashless* additive does not contribute to the sparking problem. Rather, it tends to minimize it.

Du Pont FOA-2, therefore, being an *ashless*, nonmetallic additive, can help you reduce any sparking tendency in economy-grade diesel fuels.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

CONTINUED *Tank-car lots*

will be glad to call at your refinery, study your freight rates and inventory patterns. He will then determine the most convenient handling method for you and figure the exact saving you can make. You can write, wire or phone him at our nearest sales office listed below. Why not do it now?

IN ADDITION to the dollars you save on the delivered cost of the additives, you can save on handling costs by receiving additives shipments in tank-car lots.

LABORATORY GROUP HEAD

In number of miles, the distance between Havertown, Pennsylvania and Wilmington, Delaware is not far, unless, as Harold Scheule did, you go by way of Bartlesville, Oklahoma.

Scheule, who is supervisor of the Gasoline and TEL Group at the Petroleum Laboratory, was born in Havertown in 1921. Following his graduation from Bucknell University in 1943, with a B.S. in Chemical Engineering and a Phi Beta Kappa key, Harold joined the Bartlesville staff of Phillips Petroleum Company, where he remained until 1946. Since then he's been with Du Pont at the Petroleum Laboratory.

His professional affiliations include membership in the American Institute of Chemical Engineers and the American Chemical Society. He is also active in the Coordinating Research Council.

HAROLD J. SCHEULE

Du Pont medical representatives teach safety as a way of life

Hurrying back and forth across the country, and traveling overseas, too, Dr. Stewart L. Rankin covers more than 50,000 miles a year. In the course of his travels, he has firmly impressed upon more than 20,000 refinery workers his famous slogan, "Safety is a way of life!"

DR. RANKIN is shown at right with Doctors Fenton Russell (left) and L. A. Gerlach, all of the Du Pont Medical Division.

His talks on safety are part of a unique medical service which Du Pont, as a supplier of tetraethyl lead, makes available to the oil industry. In addition to the talks, Dr. Rankin and his medical associates work closely with refinery managements, physicians, supervisors and blenders to help them maintain the very finest health and hygiene programs. Practicing *preventive* medicine, the Du Pont doctors will tell you emphatically that their greatest ambition is that they *never* have to treat a case of lead poisoning.

To help them achieve this ambition, we hope you will feel free to take advantage of their services — often!

DU PONT

Better Things for Better Living . . . *through Chemistry*

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

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ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-2338

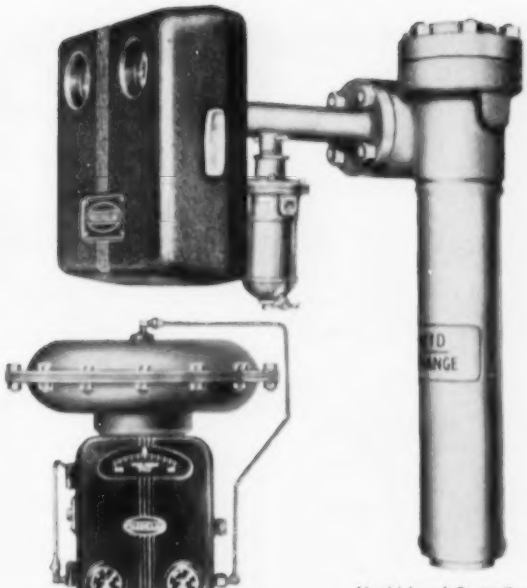
Printed in U. S. A.

Indicating, Recording and Non-indicating Controllers

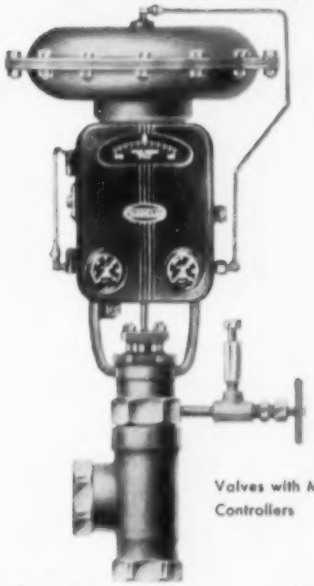
Differential Pressure Transmitters

Wide Variety of Control Valves

Valve Positioners



Liquid Level Controllers



Valves with Mounted Pressure Controllers

Mason-Neilan

Serves the Process Industries with Accurate and Reliable Control Equipment

Since 1882 Mason-Neilan has supplied industry with a wide variety of standard and specialized automatic control equipment for process and associated services. Each is a development of practical engineering based on experience gained in close contact with industrial control problems. Each is specifically designed to do an exceptional job. With Masoneilan products you get engineered equipment that assures superior performance, long life with minimum maintenance.

When writing for information please specify item or items which interest you.

MASON-NEILAN

Division of Worthington Corporation

NAHATAN STREET, NORWOOD, MASSACHUSETTS

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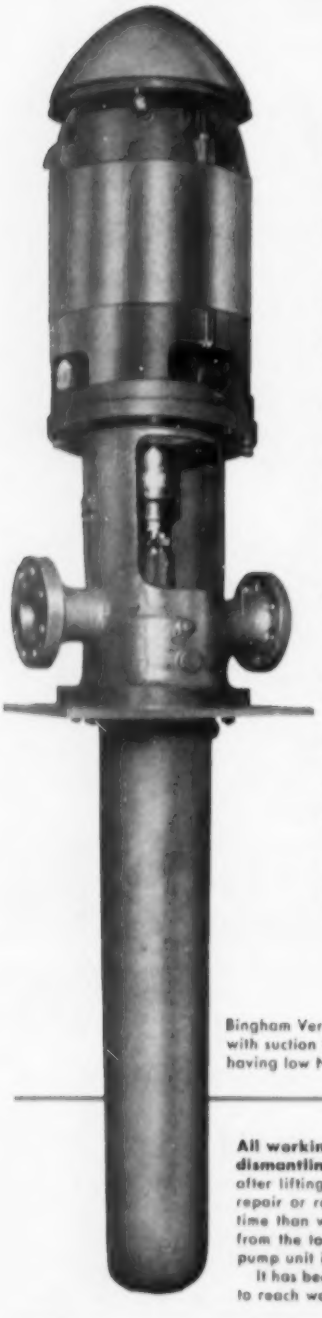
Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis • Tulsa • Philadelphia • Houston • Pittsburgh • Atlanta Cleveland • Cincinnati • Kansas City • Phoenix • Detroit • San Francisco • Louisville • Salt Lake City • El Paso • Albuquerque • Charlotte • Los Angeles Corpus Christi • Denver • Appleton • Birmingham • New Orleans • Seattle • Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

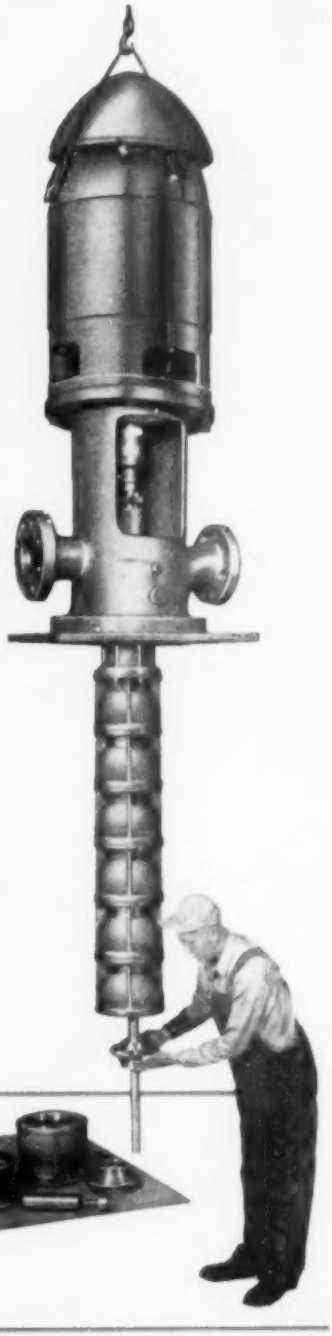
NEW! Bingham ALL WORKING PARTS



Besides bottom dismantling, which in itself greatly reduces maintenance time when attention is required, this new Bingham pump incorporates advanced design features which minimize maintenance, reducing the need for periodic inspection.

For example, all intermediate bearings (supplied of appropriate material for different pumpages) are forced-lubricated by the pumpage. Bottom bearing is lubricated even if the pump runs dry for short periods. This *dependable* lubrication greatly prolongs the life of bearings, which in conventional pumps are frequently the cause of maintenance shutdowns.

Wherever it has been installed, the new Bingham VCP Pump has given trouble-free service—plus unsurpassed smooth operation with no vibration. Available for any capacity or head. Write your nearest Bingham office for additional information, and Bulletin 109.

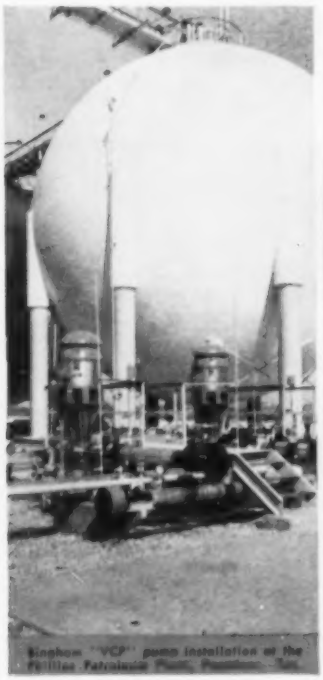


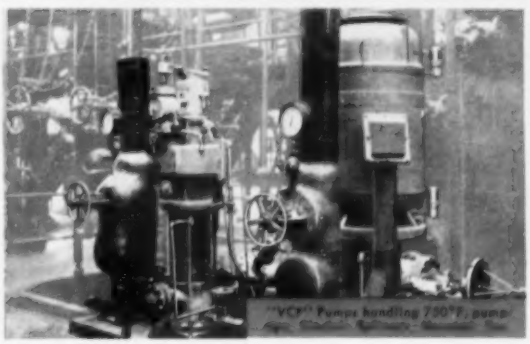
Bingham Vertical VCP assembled with suction well for installations having low NPSH conditions.

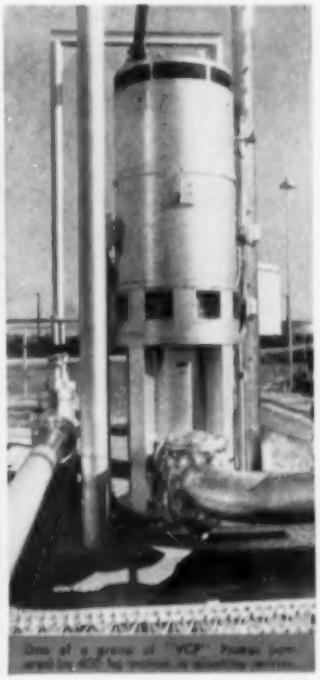
All working parts of pump easily accessible with bottom dismantling. One man can service the Bingham VCP Pump after lifting pump from well. By dismantling from the bottom, repair or replacement of any part can be made in much less time than with conventional pumps (where dismantling begins from the top, necessitating removal of driver and head before pump unit is accessible).

It has been estimated by various operators that time required to reach working parts has been reduced as much as 50%.

VCP VERTICAL PUMP FOR LOW NPSH
ACCESSIBLE WITH BOTTOM DISMANTLING







Partial list of major oil companies with Bingham "VCP" Pumps in operation or on order:

Ashland Oil & Refining Co.	Phillips Petroleum Co.	Chemical Construction Co.
Gulf Oil Corporation	American Cyanamide Co.	Champlin Refining Co.
Sinclair Oil & Refining Co.	ESSO-Standard Oil of N. J.	Pacific Gas & Electric Co.
Sun Oil Company	British American Oil Co., Ltd.	Socony-Vacuum
The Texas Company	Lakehead Pipe Line Co.	Aerojet General Corp.
Imperial Oil Co., Ltd.	Creole Petroleum Co.	Great Lakes Pipe Line Co.
Shell Oil Company	Humble Oil Company	Kaneb Pipe Line
Deere & Company	Standard Oil Co. of Indiana	Buckeye Pipe Line Co.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
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DENVER, COLO.	SEATTLE, WASH.
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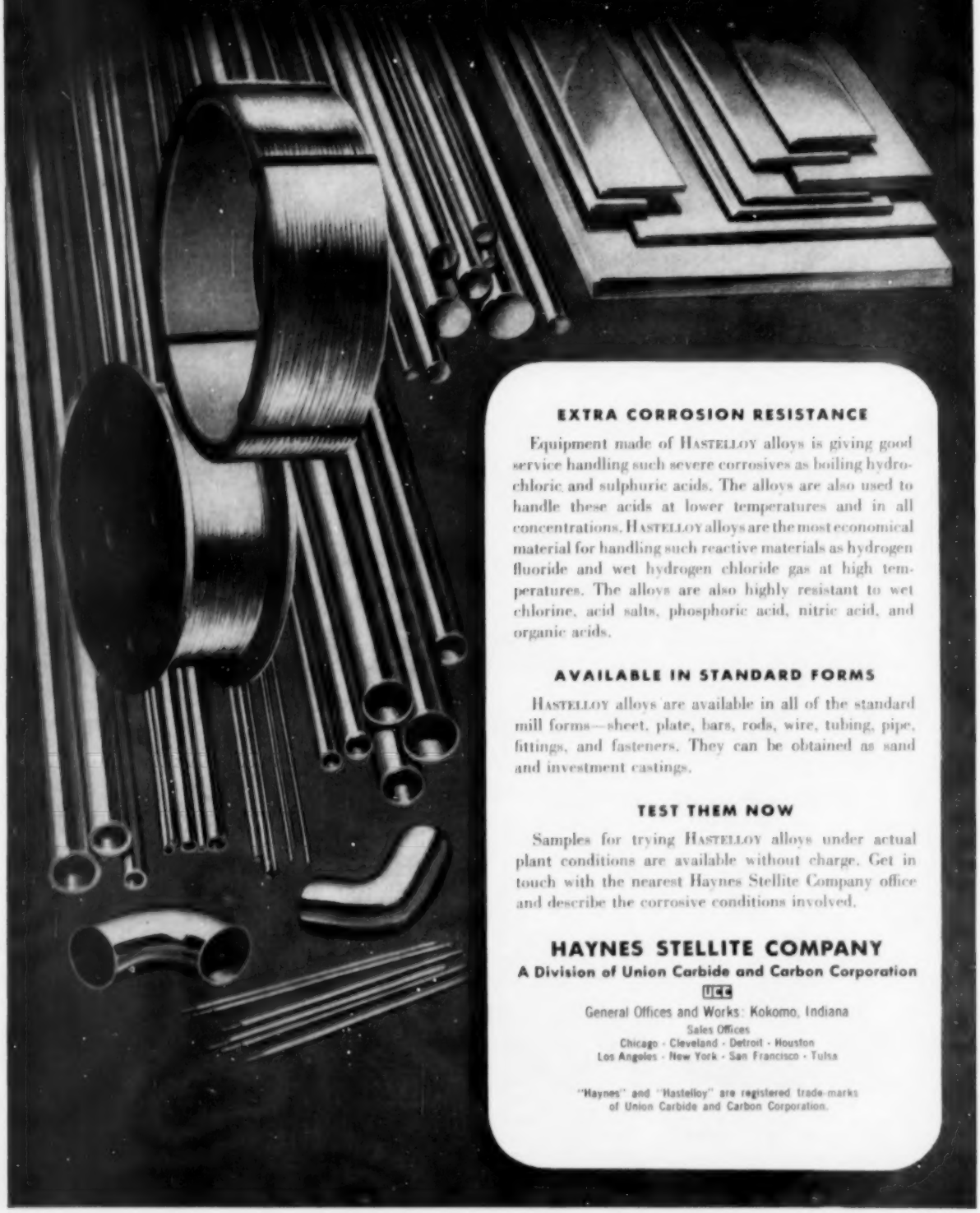
HASTELLOY Alloys in Convenient Forms

Trade-Mark

...for Superior Corrosion Resistance



EXTRA CORROSION RESISTANCE

Equipment made of HASTELLOY alloys is giving good service handling such severe corrosives as boiling hydrochloric and sulphuric acids. The alloys are also used to handle these acids at lower temperatures and in all concentrations. HASTELLOY alloys are the most economical material for handling such reactive materials as hydrogen fluoride and wet hydrogen chloride gas at high temperatures. The alloys are also highly resistant to wet chlorine, acid salts, phosphoric acid, nitric acid, and organic acids.

AVAILABLE IN STANDARD FORMS

HASTELLOY alloys are available in all of the standard mill forms—sheet, plate, bars, rods, wire, tubing, pipe, fittings, and fasteners. They can be obtained as sand and investment castings.

TEST THEM NOW

Samples for trying HASTELLOY alloys under actual plant conditions are available without charge. Get in touch with the nearest Haynes Stellite Company office and describe the corrosive conditions involved.

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

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HAVE YOU CONSIDERED THESE TWO LOW-COST WAYS TO UPGRADE OCTANES?

for catalytic cracking–
for catalytic reforming–

HOUDRY MINERAL KAOLIN

for HOUDRIFLOW and TCC MOVING BED CATALYTIC CRACKING UNITS

Maximum octane at lowest cost is provided by Houdry Mineral Pelleted Kaolin, a superior natural catalytic cracking catalyst. This new, improved catalyst offers many features including:

HIGH OCTANE
LOW COST
HIGH ACTIVITY
SULPHUR RESISTANT
HIGHEST THERMAL STABILITY
EXCELLENT REGENERABILITY

HOUDRY TYPE 3-D CATALYST

FOR CATALYTIC REFORMING UNITS

Pelleted, platinum catalyst offers improved octane number. An advanced Houdry reforming catalyst that provides increased activity and stability with no increase in cost.

PARTICULARLY COMPATIBLE WITH HOUDRIFORMING AND HOUDRY ISO-PLUS PROCESSES

HOUDRY PROCESS CORPORATION

1528 WALNUT STREET, PHILADELPHIA 2, PA.

from GAF...high pressure acetylene derivatives with 3 centers of reactivity

$HC{\equiv}CCH_2OH$ Propargyl Alcohol

a chemical intermediate and corrosion inhibitor

NEW: ELIMINATES HYDROGEN EMBRITTLEMENT

Low concentrations of propargyl alcohol in acid pickling baths inhibit or completely eliminate hydrogen embrittlement. Bend angles of 180° are obtained in a modified Zapffe method of testing. A special data bulletin is available on request.

Concentration of Inhibitor Based on Acid Content, Per cent by Weight	DEGREE OF ARC OBTAINED			
	Propargyl Alcohol	2-butyne-1, 4 diol	Commercial Inhibitor "A"	Commercial Inhibitor "B"*
0.00	69	69	69	69
0.25	180	48	43	68
0.5	180	54	36	180
1.0	180	59	77	123
2.0	180	150	103	145
4.0	180	123	66	133
8.0	180	130	133	180

*Contains 11% propargyl alcohol.

chemical intermediate:

Propargyl alcohol, $HC{\equiv}CCH_2OH$, with its three centers of reactivity, primary alcohol, triple bond and active hydrogen, has proven itself a valuable tool in the synthesis of pharmaceuticals, essential oils, agricultural and specialty chemicals.

corrosion inhibitor:

Propargyl alcohol is an excellent corrosion inhibitor for mineral acids and stabilizer for chlorinated solvents.

properties:

Propargyl alcohol is a colorless, stable liquid, infinitely miscible in water, benzene, ethanol and other organic solvents.

$HC{\equiv}CCH_2Br$ Propargyl Bromide

a chemical intermediate and agricultural soil sterilizer

chemical intermediate:

Propargyl bromide, $HC{\equiv}CCH_2Br$, has three centers of reactivity; triple bond, bromine atom, and acetylenic hydrogen. Synthesis of terpinoid structures such as vitamin A, plant growth hormones, etc., is possible through Reformatsky-type reactions. Some propargyl amines and propargyl ethers synthesized from propargyl bromide have physiologic activity as morphine antagonists and hormones. Used in the synthesis of propargyl substituted barbiturates.

soil fumigant:

Propargyl bromide has been found to be highly effective as an agricultural soil fumigant.

properties:

Almost colorless liquid, insoluble in water, soluble in ethers, benzene and hydrocarbons.

For technical information, price schedules and samples write to:

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GENERAL ANILINE & FILM CORPORATION
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ANTARA gaf

From Research to Reality

another complete refinery

FOSTER WHEELER

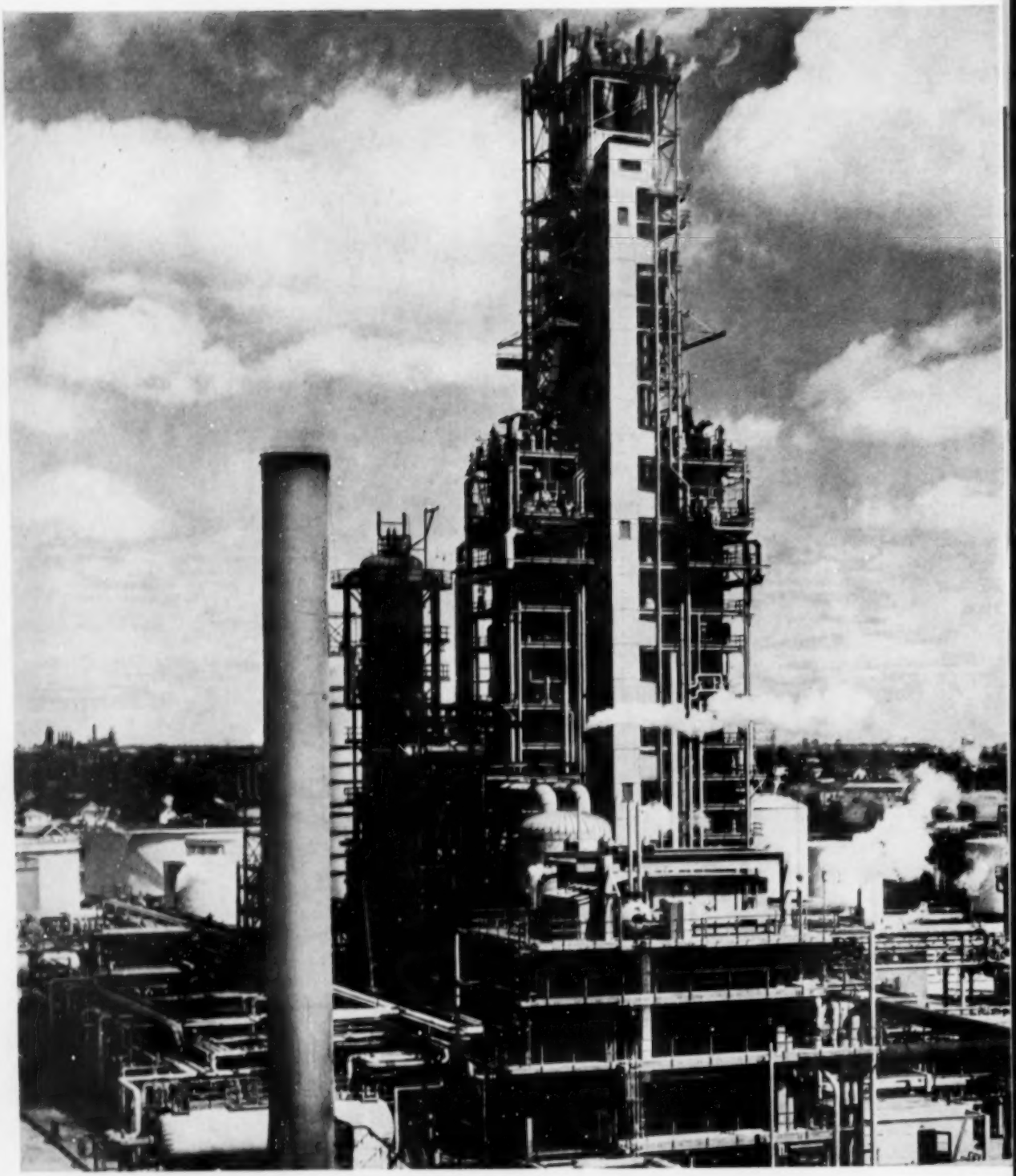
At the Halifax plant of Imperial Oil Limited, Halifax, N. S., a completely new and up-to-date refinery is now "On stream". All the processing units and the utility plant were designed and constructed by Foster Wheeler.

The photograph, shows the following process units, from left to right: 41,600 bbl/day two-stage Crude Distillation unit; 13,000 bbl/day Model IV Fluid Cat Cracking unit; Light Ends Plant; 4,000 bbl/day Catalytic Polymerization unit.

Also included will be a 7,000 bbl/day Powerformer with integral Hydrofiner for feed preparation and a 500 bbl/day LPG unit, scheduled for completion before the end of the year.

Refinery Operating Records Prove...

Fuel Costs Go Down When



A B&W CO Boiler Goes In

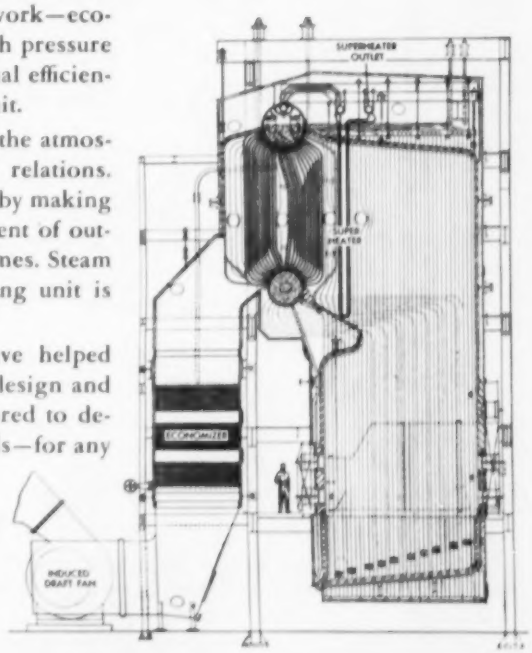
Savings Can Be Calculated in Thousands of Dollars... Atmosphere is Kept Clean

Designed and developed to raise refinery thermal efficiency to still higher levels, the B&W CO Boiler has effectively demonstrated its *reliability, efficiency and economy in extended, sustained service.*

FUEL SAVINGS ARE SUBSTANTIAL because sensible and combustible heat content is put to work—economically. Steam can be produced at high pressure and temperature, resulting in high thermal efficiencies for prime movers of the cracking unit.

OTHER ADVANTAGES include keeping the atmosphere clean for improved community relations. Also, the CO Boiler simplifies operation by making your cracking unit completely independent of outside sources of steam and energy at all times. Steam is always available—whether the cracking unit is operating or shut down.

DIFFERING REFINERY CONDITIONS have helped develop CO Boilers that are flexible in design and arrangement. B&W engineers are prepared to design a unit that will meet your exact needs—for any steam pressure or temperature and *any size* cracking unit—large or small. Write for details—The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, New York.



B&W CO Boiler in midwestern refinery delivers 190,000 pounds of steam per hour at 500 psi and 575 F. It saves 44½ million BTU's per hour.

BABCOCK & WILCOX

B&W

BOILER DIVISION

G-814-CO

Stauffer...

major source of

CHLORINATED HYDROCARBONS

PERCHLORETHYLENE?

Stauffer's 'Perk' is available in the Technical grade for industrial degreasing . . . and in the Drycleaning grade . . . both grades stabilized for use in all standard synthetic units.

METHYLENE CHLORIDE?

Lowest in density, boiling point, freezing point and toxicity of all the chlorinated hydrocarbons, Stauffer's Methylene Chloride is available at highest levels of purity for every technical and industrial use.

CARBON TET?

Stauffer is a major source of this widely used solvent, carrier, flame inhibitor, fire extinguisher, and chemical intermediate.

CHLOROFORM?

Stauffer's present substantial facilities will be greatly enlarged in 1957 by the addition of a new plant for the manufacture of Chloroform at Louisville.

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2. GETTING THE MOST OUT OF YOUR VALVES . . . Four page technical discussion explaining selection, installation, inspection and maintenance of stainless steel valves.

3. CATALOG 55D (VALVES) . . . Sixty-eight page simplified stainless steel valve catalog includes engineering drawings, weights, size ranges, dimensions and basic material data.

4. CATALOG 55F (FITTINGS) . . Complete stainless steel fitting catalog giving engineering drawings, dimensions and basic material data.

5. VALVES TO COMBAT CORROSION . . . 75 questions and answers selected from Cooper Alloy valve clinics covering materials, operations, service problems, installation and repair.

6. STAINLESS STEEL VALVES AND FITTINGS IN THE PAPER INDUSTRY . . . Eight page technical article covering alloys, valve selection, design factors, installation, maintenance, operation and inspection of stainless steel valves and fittings used by the paper industry.

7. PLASTIC PUMPS . . . Four page folder describing the Vanton "Flex-i-Liner" pump. Full and cut-a-way views, plus performance charts and material selection hints are included.

8. PLASTIC PIPE AND FITTINGS . . . 8 page catalog on Vanton P-Line (PVC), N-Line (Buna N) and S-Line (Styrene) pipe, valves and fittings.

9. PUMPING CORROSIVES . . . Four page article describing the transfer of hydrochloric, formic, lactic acid and salt solutions at Litho Chemical.

10. ADVANCED KNOW-HOW . . . Series of case studies showing how advanced know-how made possible the economical production of high alloy products considered difficult or impossible to cast.

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13. ALLOY REFERENCE CHART . . . Revised four page pamphlet listing alloy designations, applications, properties and analysis of corrosion and heat resisting alloys.

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15. NEWSCAST . . . An eight page bi-monthly publication devoted to reporting technical material of value to those interested in corrosion resistant castings, fittings, valves and pumps.

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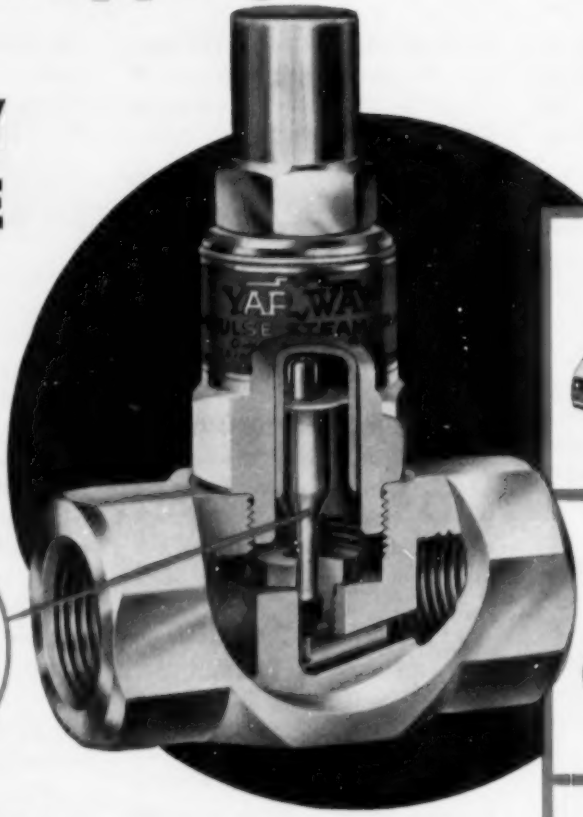
 (To obtain more data on advertised products see page 208)

the impulse that revolutionized steam trapping

YARWAY IMPULSE STEAM TRAP



the only moving part

...a small stainless steel valve that literally floats on the condensate load. Gets equipment *hot in a hurry*—and *keeps it hot!*

SERIES 60 and 120

For all *normal* trap requirements, pressures to 400 and 600 psi.

½" No. 20-A

For *light loads* on tracer lines, steam mains, small presses, etc.

SERIES 40

For *heavy loads* requiring extra high capacity steam traps.

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For *high pressures, high temperatures.* (Flanged or welding connections.)

Twenty years ago YARWAY applied a unique theory of thermodynamics to steam traps—and gave industry the amazing YARWAY Impulse Steam Trap.

Today—over a million YARWAY Impulse Steam Traps later—advantages like the following continue to convert new users, and convince old users to standardize on the YARWAY Impulse:

- QUICK HEAT-UP AND EVEN TEMPERATURES OF EQUIPMENT
- GOOD FOR ALL PRESSURES WITHOUT CHANGE OF VALVE OR SEAT
- SMALL SIZE—LIGHT WEIGHT
- ONLY ONE MOVING PART
- STAINLESS STEEL—minimum maintenance
- WON'T FREEZE UP
- A COMPLETE LINE of sizes and types for every requirement
- IMMEDIATELY AVAILABLE from 270 local Industrial Distributors

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YARNALL-WARING COMPANY
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YARWAY IMPULSE® STEAM TRAP

OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED

DO *Warm* days

AND *Cool* nights . . .

"SEE-SAW" THE PEP OUT OF YOUR MOTOR FUEL?

BLENDING WARREN NATURAL GASOLINE WITH YOUR PRESENT HIGH QUALITY MOTOR FUEL WILL GIVE IT . . .

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SO NECESSARY FOR SUPERIOR PERFORMANCE

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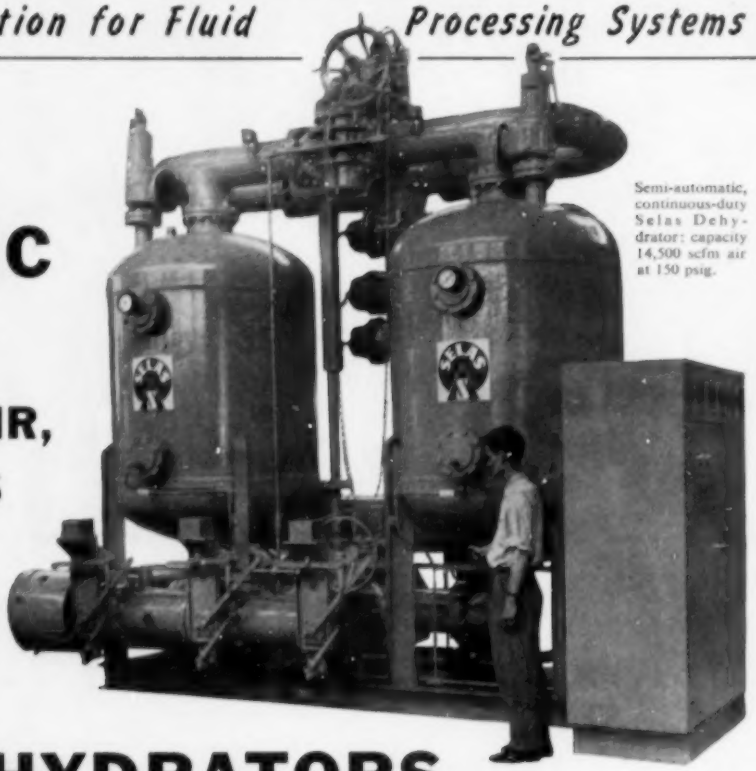
Continuous AUTOMATIC DRYING *of* COMPRESSED AIR, PROCESS GASES *and* LIQUIDS *with*



Semi-automatic, continuous-duty Selas Dehydrator; capacity 14,500 scfm air at 150 psig.

SELAS DEHYDRATORS

Designed for all processing conditions, Selas Dehydrators effectively and economically dry *gases* . . . compressed air, carbon monoxide, hydrogen, oxygen, gaseous hydrocarbons, inert gases . . . and *liquids* . . . propane, butane, kerosene, benzol, toluene, xylene and solvent naphthas.

- Desiccants employed are selected to meet moisture-removal requirements.
- Reactivation by steam, gas or electric heat.
- Operating pressures range from atmospheric to 6000 psig.

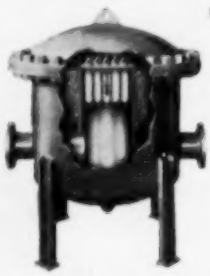
Selas Dehydrators are available for manual, semi-automatic and fully automatic operations. Capacities to 15,000 scfm for gases; up to 200 gpm for liquids.

OTHER SELAS FLUID PROCESSING EQUIPMENT

LIQUID-GAS SEPARATION

Liqui-Jector—

Continuous automatic removal of water, water-oil emulsions and dirt from compressed air and process gases (nitrogen, hydrogen, oxygen, fuel gases); condensate oil, dirt and other impurities from steam. Capacities from 10 to 5000 scfm; pressures, 25 to 3500 psi.



LIQUID-GAS SEPARATION . . . PLUS HYDROCARBON VAPOR ADSORPTION

Vape-Sorber—

Continuous removal of hydrocarbon vapors, liquid hydrocarbons, water hydrocarbon emulsions and dirt from compressed air and process gases (nitrogen, hydrogen, carbon dioxide, inert gases). Capacities from 100 to 5000 scfm at inlet pressures up to 3500 psi.

LIQUID-LIQUID SEPARATION

Liquid-Separator—

Continuous separation of emulsions in steam distillations, solvent extractions, organic reactions. Dewatering of solvents and hydrocarbons; recovery of organic liquids. Capacities of single units range from 10 to 6000 gph.

Write for Air-Gas Processing Bulletin 129

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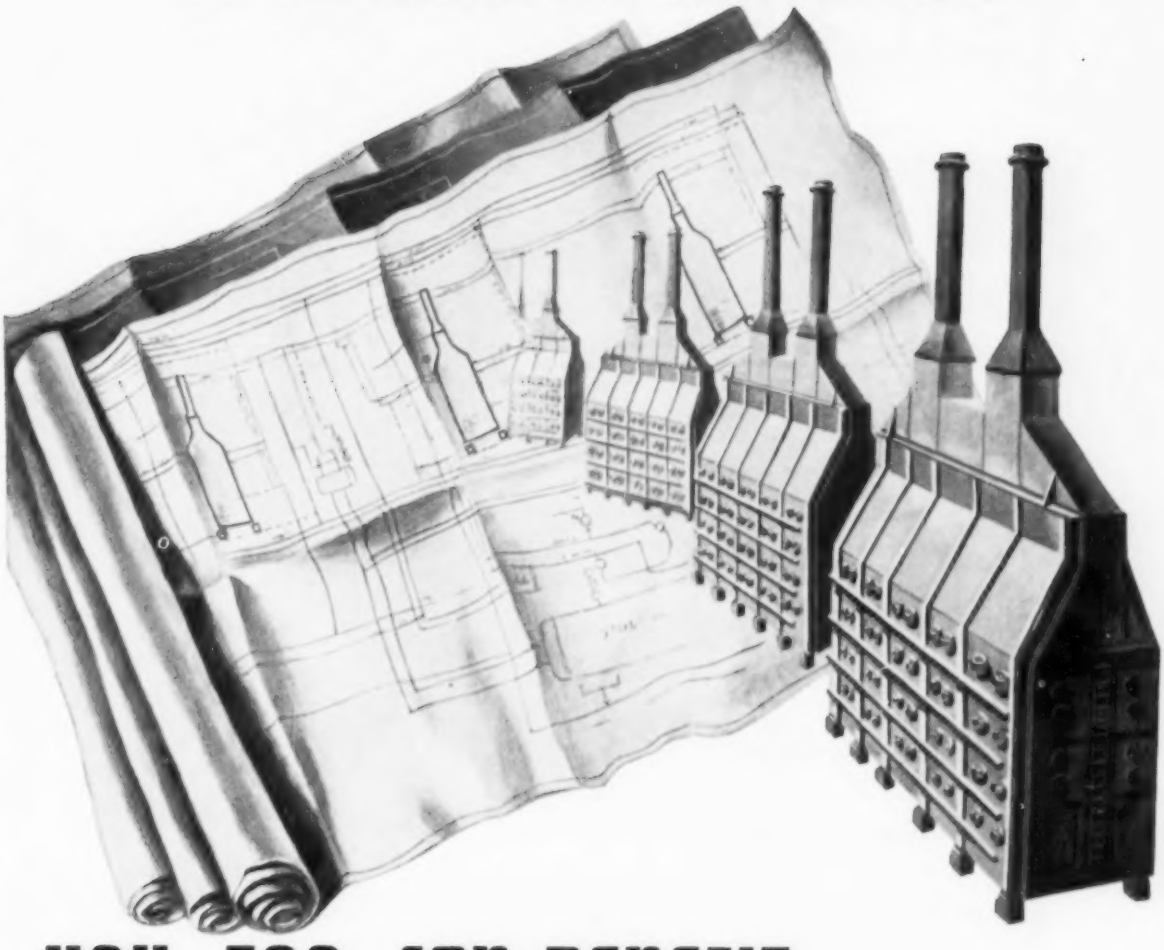
Heat and Fluid Processing Engineers
DEVELOPMENT • DESIGN • CONSTRUCTION

IN ETHYLENE PRODUCTION



YOU, TOO, CAN BENEFIT

...from Selas Gradiation® Heating

OPERATION AT THE DESIGNED CAPACITY from the moment of start-up . . . uninterrupted production of ethylene flow . . . versatility in processing different feed stocks . . . are important benefits that will be assured by Selas Gradiation Heating in your new or expanded ethylene operation.

Based on a number of Selas Heaters in ethylene service, you can expect:

- "On stream" periods, without shutdowns, well in excess of 30 days
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- Zone Control of heat input which enables meeting any time-temperature curve in pyrolytic or catalytic reactions and high temperature preheating.
- Optimum conditions even with extreme variations in feed stocks
- Uniform heat distribution on the entire tube surface extends tube life by eliminating local overheating, and material degradation at the tube wall.
- Controlled combustion, with little or no excess air to cause external oxidation of the tubes . . . no lag in response to controller demand.

Send for copy of reprint, "Try the Gradiation Heater for Economical Ethylene Production" and Bulletin 129, "Gradiation Heating for Petroleum and Chemical Processing."

SELAS *Heat and Fluid Processing Engineers*

CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

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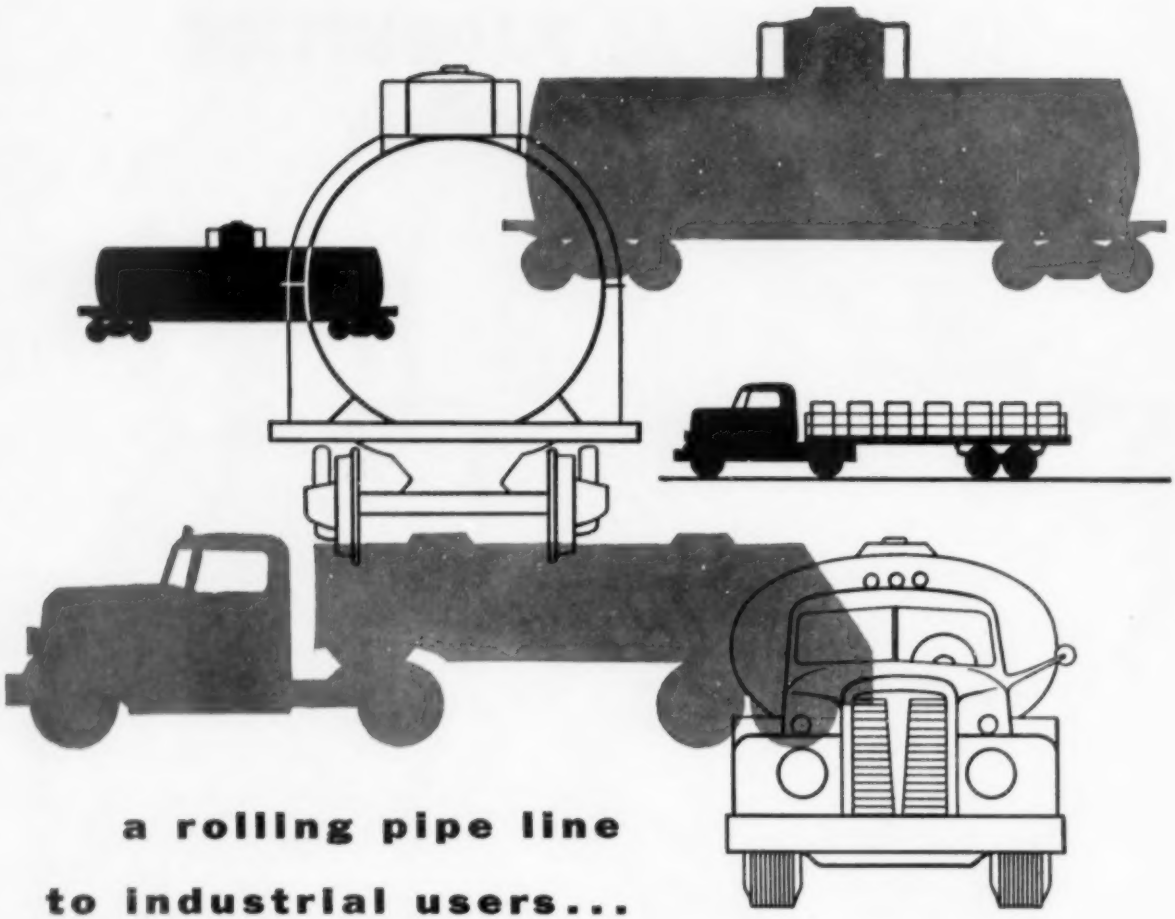

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to industrial users...

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direct to you...

Fast deliveries, straight from plant to you, guarantee that Mathieson mono-, di-, and triethanolamine reach your process in the original containers. There's no repacking or rehandling to impair the purity of these Mathieson products.

Tank car, tank truck, and drum shipments arrive directly from our modern Doe Run plant at Brandenburg, Kentucky; LCL deliveries, in plant packaging, from numerous local distribution points. For technical information and samples, call an Olin Mathieson representative today.

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My Problem is Surface Fouling!

Vogt has the answer in the positive flow-thru Scraped Surface Exchanger. Surfaces are swept clean by the rotating scraper action, eliminating the headache of fouled heat transfer surfaces.

We Have A Tough Crystallization Problem!

Because Vogt Scraped Surface Exchangers maintain uniform heat transfer rates crystallization is under control at all times. The rotating blades free the crystals from the walls and they are discharged as a slurry.

Our Product Must Be Mixed As It Flows!

Chemical Processors are particularly happy with the Vogt Scraped Surface Exchanger, because the product is thoroughly mixed by the rotating scraper blades as it flows.

Our Solvents are Dangerous to Use-Expensive to Lose!

Vogt Scraped Surface Exchangers are closed, pressure-type systems which permit the use of flammable, volatile and expensive solvents with complete safety and no danger of solvent loss.

Vogt

Send for Bulletin PE-1 today. Address Dept. 24-RIPP.

Has the answer in its Scraped Surface Exchangers

OTHER VOGT PRODUCTS: Drop Forged Steel Valves, Fittings and Flanges in a complete range of sizes • Petroleum Refinery and Chemical Plant Equipment • Steam Generators • Heat Exchangers • Ice Making and Refrigerating Equipment.

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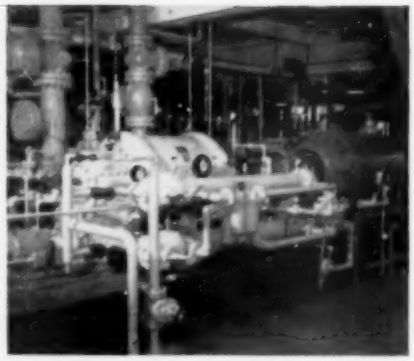
SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W Va., Cincinnati, San Francisco

Carrier Centrifugal Compressors



on the job at

Canadian Petrofina Limited

Two Carrier Centrifugal Compressors are on the job at the Pointe aux Trembles plant of Canadian Petrofina Limited. One of the two 800-hp machines serves as a recycle compressor in the production of high-octane gasoline from low-grade naphtha. The other compresses hydrocarbon vapors released from the reactor during the alkylation process and plays a vital role in producing gasoline of very-high-octane rating.

Carrier makes a complete line of centrifugal and axial flow compressors for gas compression and refrigeration—up to 10,000 hp in a single unit. Hundreds of these dependable Carrier machines are on the job at dozens of chemical plants and refineries across the country—such as Olin Mathieson Chemical Corporation, Standard Oil Company of California, Wyandotte Chemicals Corporation, The Texas Company. May we assist you?

If you'd like a copy of our booklet, **"Centrifugal Compressors for Industry,"** please call your nearest Carrier office. Or write Carrier Corporation, Syracuse, New York.

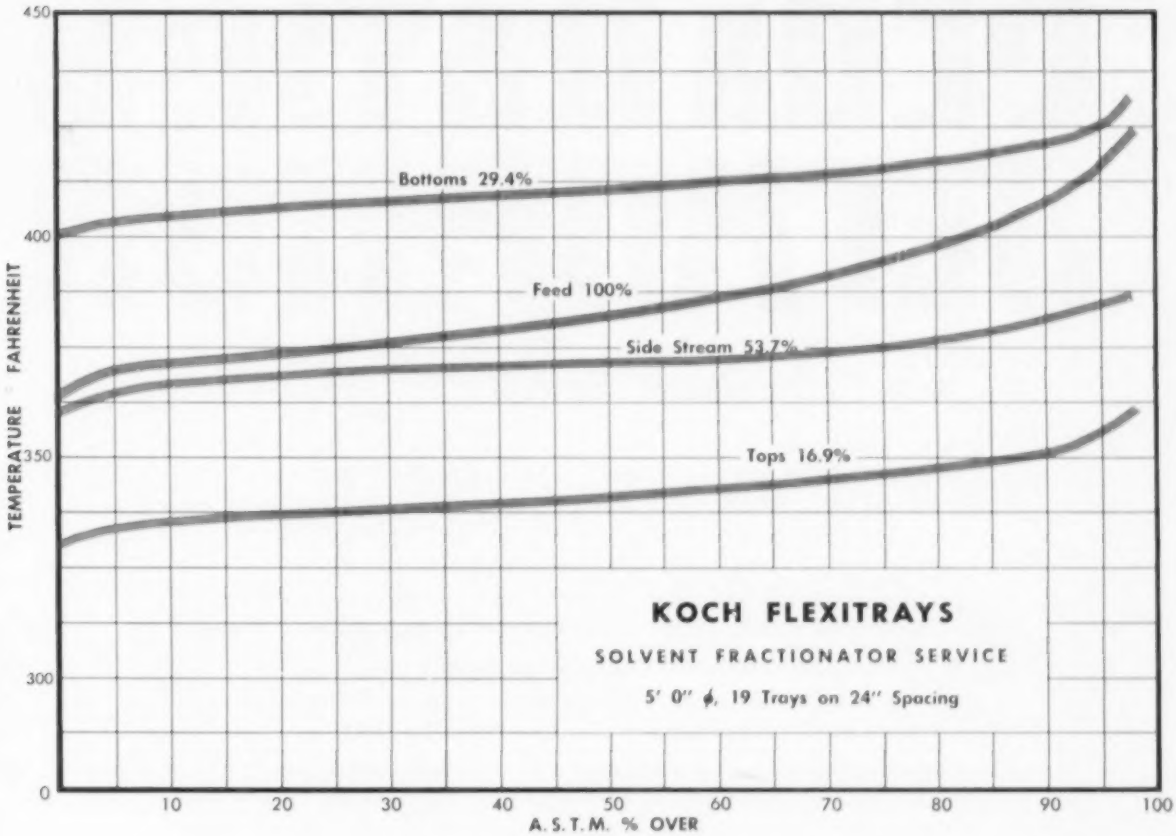
Carrier

centrifugal compressors
refrigerating equipment

Repeat orders PROVE

Top Performers Prefer Koch Flexitrays

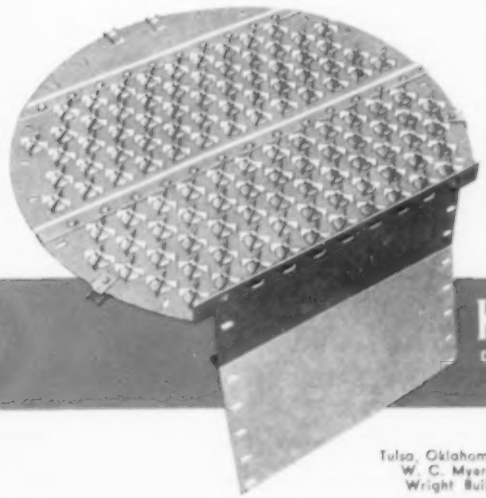
FOR SOLVENT FRACTIONATION



The above graph illustrates the clean separation of relatively short boiling range solvents. The required flexibility and high tray efficiency for such separations has always presented a challenge to tray designers.

Numerous repeat orders from large solvent producers indicate an eventual complete changeover from bell caps to Flexitrays for this exacting service.

Flexitray's adaptability to existing downcomers and supports makes such replacements highly economical. The performance records of the Koch Flexitray are outstanding. Wire, write, or phone us on its application to your problem.



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get cleaner

more economical liquid/vapor

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with "Schuylernit" Entrainment Separators

Stop costly liquid loss . . . in chemical and petroleum process equipment at lower cost with "Schuylernit" Entrainment Separators (mist eliminators). Specifically designed and constructed to separate liquid and small solid particles from any gas or vapor, "Schuylernit" Entrainment Separators assure these advantages: Elimination of liquid loss . . . increased throughput . . . improved process efficiency . . . reduced vessel sizes . . . reduced contamination . . . improved product quality.

- **"Schuylernit" Entrainment Separators are highly recommended for:** Vacuum and flash towers, gas absorbers, evaporators, distillation equipment, knock-out drums, steam drums, scrubbers, gas filters, compressors.

Immediate delivery on round, square or special shapes in any thickness for new or existing equipment. Send for illustrated Bulletin 203, Schuyler Manufacturing Corp., 81 Porete Avenue, North Arlington, New Jersey.

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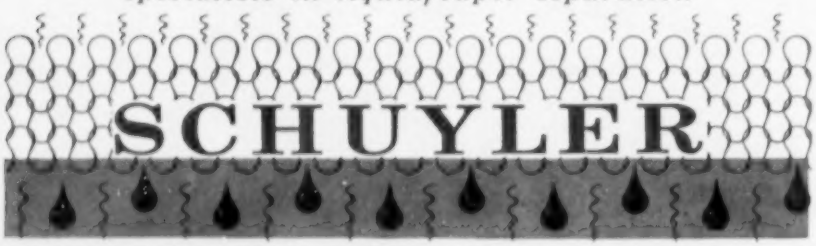
specialists in liquid/vapor separation



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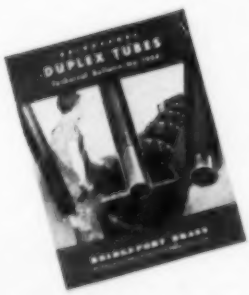
WAYS TO LICK CORROSION!

Let BRIDGEPORT Help Find the Way That's Best for You

No pipe dream! Bridgeport Duplex Tube can help you lick dual corrosion conditions in more than 101 *different* ways! Duplex Tube matches one alloy against inside corrosion and another alloy against outside corrosion. More than 101 Duplex combinations are available. Each is designed to lick a particular combination of corrosive conditions.

Whatever your corrosion problem, get in touch with Bridgeport. Write for our questionnaire which has been especially prepared to aid you in describing your corrosion problem. Our Corrosion Laboratory will be glad to help you select the tube alloys that will serve you best.



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Dual corrosion and its prevention is discussed at length in Bridgeport's Duplex Tube Handbook. Write for your copy today.

—Photograph courtesy of Standard Oil Co. of N. J.

with Ljungstrom® Air Preheaters, four of your present stills can do the work of five

You'll have far less slag—much less downtime for maintenance—with the Ljungstrom Air Preheater. This unit produces more complete combustion, at higher temperatures, because preheated air mixes more thoroughly with fuel. And in addition, Ljungstrom efficiency makes possible finer process control and advanced furnace designs. Thus, Ljungstrom savings are real and measurable. One still, Ljungstrom equipped, added $58,000 of income annually from higher product quality alone.

How fast is "WRITE OFF"?

Unusually short. Major savings are gained from higher average octane ratings. And other Ljungstrom advantages—up to 20% fuel savings . . . more economical furnace design, with no need for convection surfaces . . . use of many fuels you used to throw away . . . consistently higher throughput . . . shorter turnaround time—mean that a Ljungstrom is paid out in a very few months.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits attainable in fuel burning equipment—call or write the Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

We've written a NEW RECORD...

Our printer has just delivered to us a brochure which gives a little of the history of our Company and is liberally illustrated with pictures of completed projects. If you are part of the management team in the refinery, chemical plant, ore processing, secondary recovery or gas processing industry, we believe you will be interested in seeing this.

Just have your secretary drop us a line on your company letterhead and a copy will be forwarded to you promptly.

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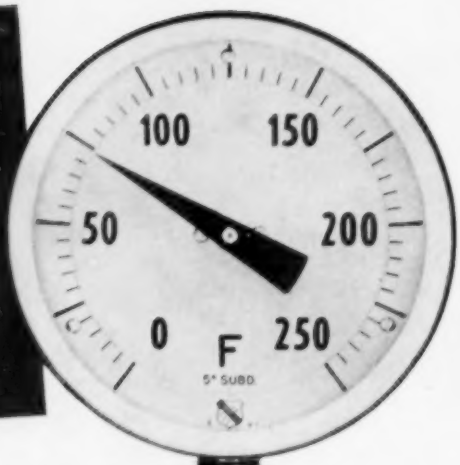
A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

NEW YORK TULSA TORONTO

"Every Angle" Design Maxivision* Accuracy Bi-Metal Actuation

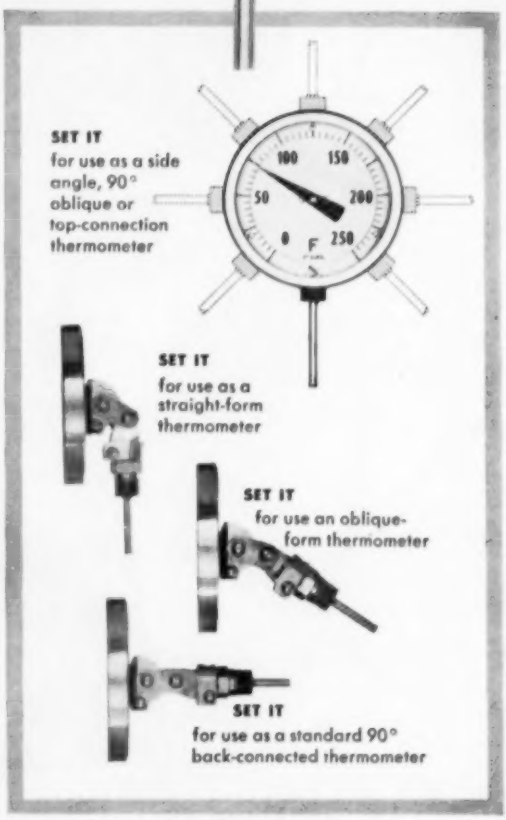


Now... all 3 in one 'American' Thermometer

Only this new American Thermometer* gives you the three features most demanded in a dial thermometer. The "Every Angle" design allows you to install this thermometer *anywhere* . . . then angle it in the direction that provides easiest reading. The anti-parallax Maxivision dial guarantees the surest, sharpest, easiest reading. Graduations are carried on a raised ring, set close to the cover glass, with an index-type, functional pointer set at the same level. The result – no perspective effect – parallax error practically eliminated. Finally, bi-metal actuation insures high sensitivity, economy, and surety of operation.

Install the new American "Every Angle" Bi-Metal Dial Thermometer anywhere – inside or out. Its climate-proof case defies any weather condition. The full use of these thermometers in any process plant makes possible temperature readings with the same ease and facility of those of a pressure gauge. Write today for complete information. Ask for Bulletin 148.

*Pat. App. For



SPECIFICATIONS

5-Inch Type 5-6060 American "Every Angle" Bi-Metal Dial Thermometer

Temperature Ranges: From minus 80° to plus 1000° F. Accuracy within 1% of range. *Dial Size:* 5". Scale approximately 10½" long. *Bi-Metal Coil:* Low mass, with single helix close to inside wall of stem assures high sensitivity. Silicone fluid dampens vibration, accelerates transfer, speeds response. *Case:* Stainless steel. *Bezel:* Threaded to case. *Front:* Clear, extra-heavy glass set in channeled gasket to seal case. *Pointer:* Functional type, adjustable from front. *Stem:* Lengths – 4" to 24", 18-8 stainless steel. All joints welded. *Connection:* Fixed, ½" NPT. *Separable Sockets:* Available in all materials and sizes normally required.

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MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

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Your home is made with BRICK . . . *no matter what you build it of!*

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You see, refractory brick carries the load within industry. But, beyond industry, everyone comes in direct contact with refractories in daily living. The making of refractory products is the most basically necessary industry—with the exception of agriculture—there is.

To provide the right refractory industry needs—castables, plastics, ramming mixes, firebrick, mortars, insulating brick and insulation—General Refractories operates the world's largest refractories research laboratory . . . constantly seeking perfection . . . drawing resources from all over the globe.

A Complete Refractories Service

GENERAL REFRACTORIES COMPANY
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A COMPLETE REFRACTORIES SERVICE FOR THE PETROLEUM INDUSTRY

LITECAST 50—A hydraulic-setting insulating castable refractory material, having a density of approximately 50 lbs. per cubic foot. Its extreme light weight and exceptionally low thermal conductivity make it an efficient and economical heat insulator. Recommended for vessel linings and backing for brickwork for other heavier castable refractory materials.

HIGH-STRENGTH BRIK-CAST—A hydraulic-setting castable refractory material unique in that it contains more bonding agent, which results in a product more resistant to the physical actions of impact, erosion, and load bearing. Used extensively for lining regenerator chambers and catalyst lines in catalytic cracking units.

LITECAST 50-M—A 50-pound density insulating castable, having a high degree of purity, used as a liner in vessels and lines where atmospheres must be controlled, or contamination of internals must be avoided. LITECAST 50-M may be applied in the same manner as standard hydraulic-setting castables.

BRIK-CAST 3000—A hydraulic-setting castable refractory material, composed of clays and bonding agents having the highest purity, resulting in a product with a high operating temperature (3000° F.), and resistance to reducing atmosphere in carbon monoxide attack. Recommended for sulphur burner chambers and other vessels operating above normal cracking and reforming temperatures.

THE PROBE PROVIDES THE PROOF

proof that Kontol corrosion inhibitors effectively protect against hydrogen blistering in fractionating systems associated with catalytic cracking units. In case after case, the use of Kontol reduced hydrogen penetration, as indicated by probes, from a 20 to 25 psi build up per eight hour period to the 0 to 3 psi range. In addition, in every case, blistering was materially reduced or arrested. Metal losses were reduced in the 70% to 90% range and, due to Kontol's powerful detergent action, fouling and scaling on condensers, towers and exchangers became negligible.

Complete information and instructions for the fabrication of a hydrogen probe are available on request from the Tretolite Company.

Kontol is an effective corrosion preventive in virtually every major element of refining equipment. For complete information ask the Kontol service engineer in your area, or write to

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION
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Chemicals and Services for the Petroleum Industry

DEMULSIFYING, DESALTING, CORROSION PREVENTING, WATER DE-OILING, PARAFFIN REMOVAL, SCALE PREVENTING, PRODUCTION STIMULATING

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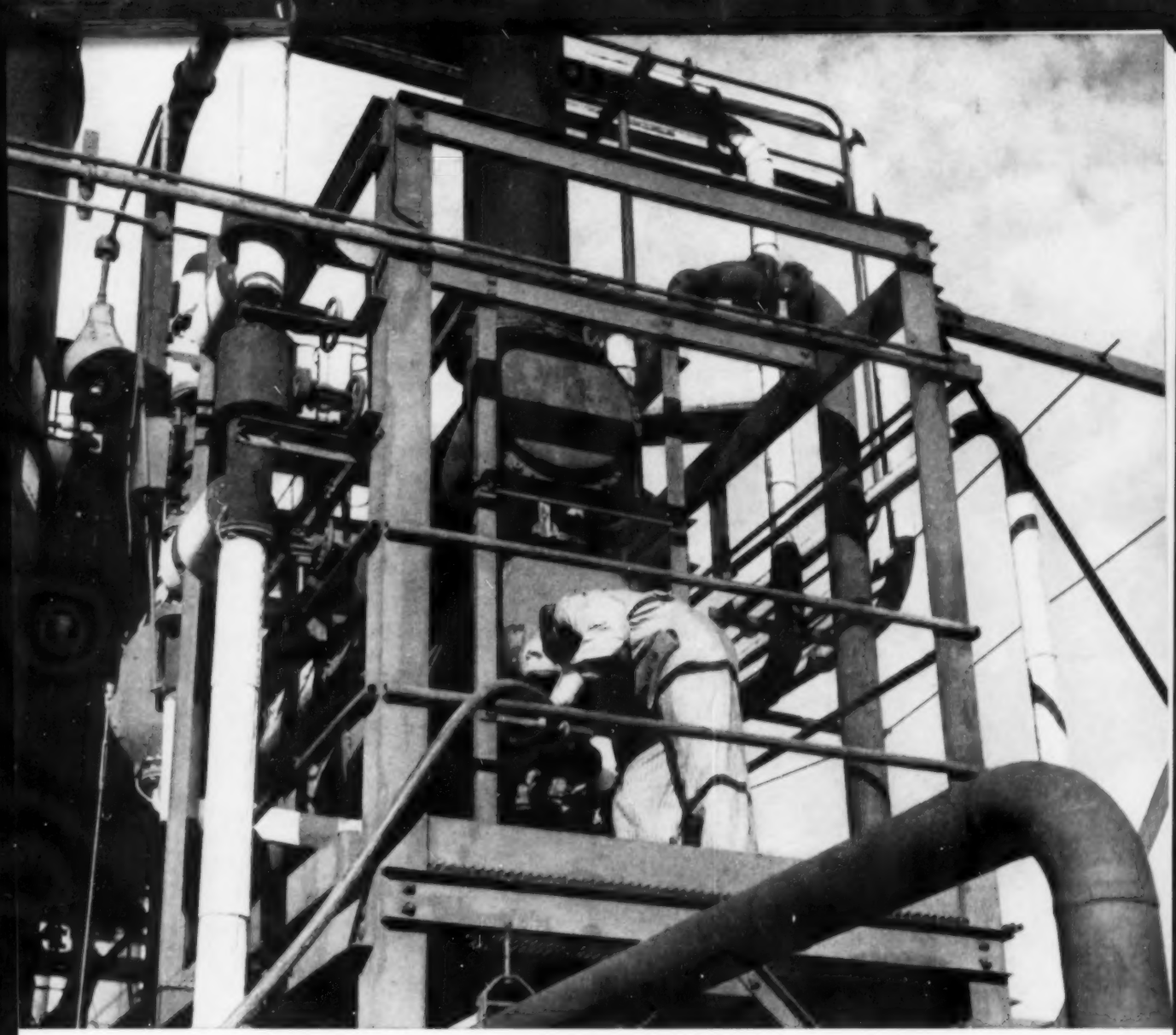


There's too much at stake —clean it right

Chemical cleaning involves costly equipment and often work stoppages. It's a job for experts. Let Dowell protect that equipment and keep production losses to a minimum when you have scale or sludge problems.

In over 15 years our trained engineers have serviced virtually every kind of equipment in plants, mills and refineries throughout industry. In fact, Dowell has cleaned over 10,000 boilers alone!

This experience means lower costs to you—in more thorough work, restored efficiency and less production loss.

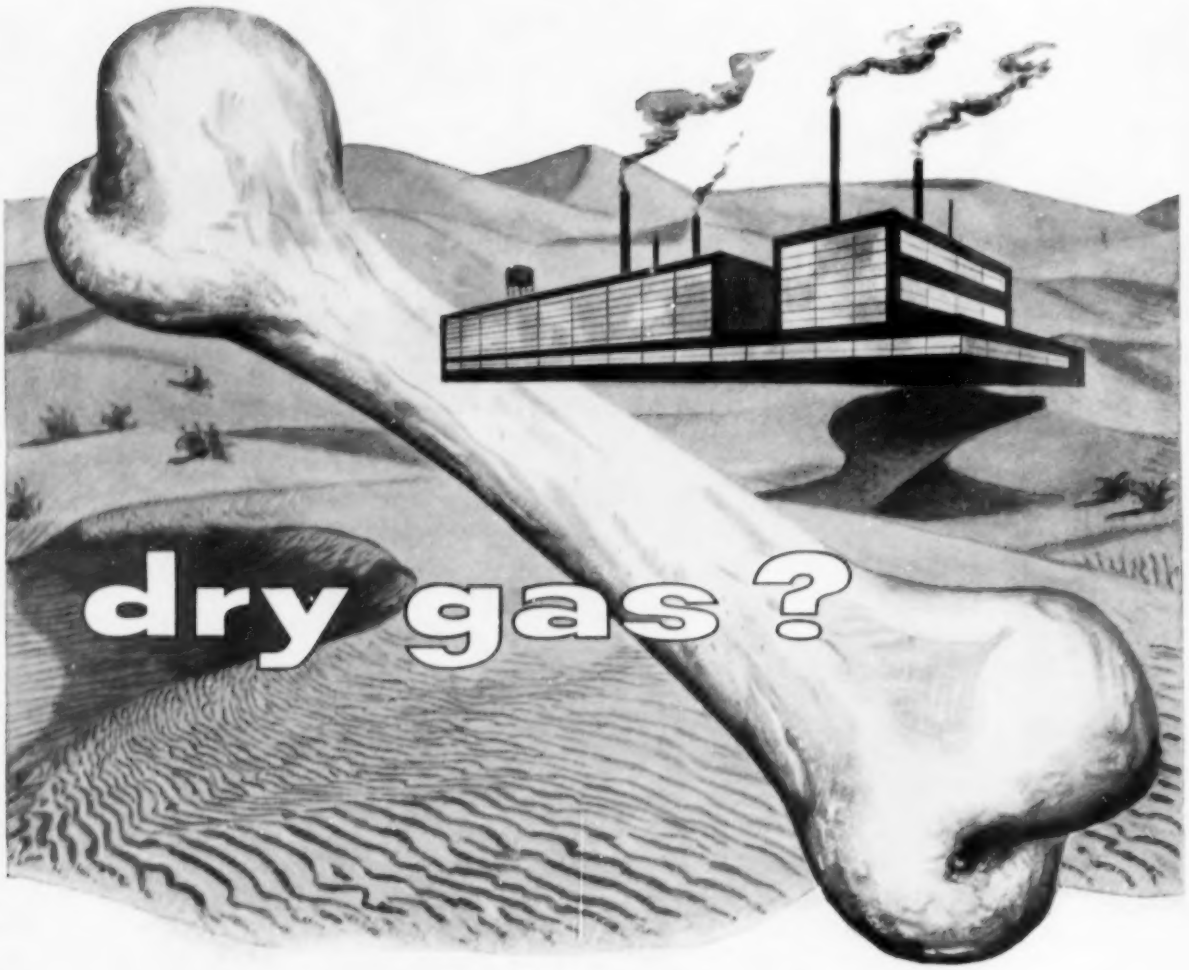
Furthermore, Dowell engineers know you value the safety of your men and equipment. Dowell uses only the latest safety equipment and techniques to eliminate hazards and accidents. Our engineers work closely with your safety personnel to establish the safest possible working procedures.

Call the nearest of more than 165 Dowell offices. An experienced engineer will be glad to talk over and help you with your cleaning problems any time — at no obligation. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. I-32.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

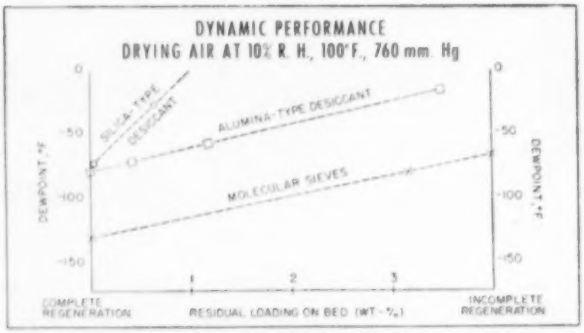


Now you can dry gases drier than dry!

LINDE Molecular Sieves can dry your gases—air, hydrogen, chemical streams—more thoroughly than any other commercial adsorbent. They will duplicate laboratory performances—*in your plant*—under normal *production* conditions.

Even though your gas stream may already be partly dried, Molecular Sieves will remove the last traces of moisture. Only a small volume of adsorbent is required. The same combination of high capacity and low dew-point is also obtained at high temperatures, up to 200°F.

This is SUPER-drying! Dynamic performance is shown in the accompanying graph. This superior performance also can be expected at higher relative humidities and at other temperatures and pressures. Of particular significance in production is the relative insensitivity of Molecular Sieves to incomplete regeneration.

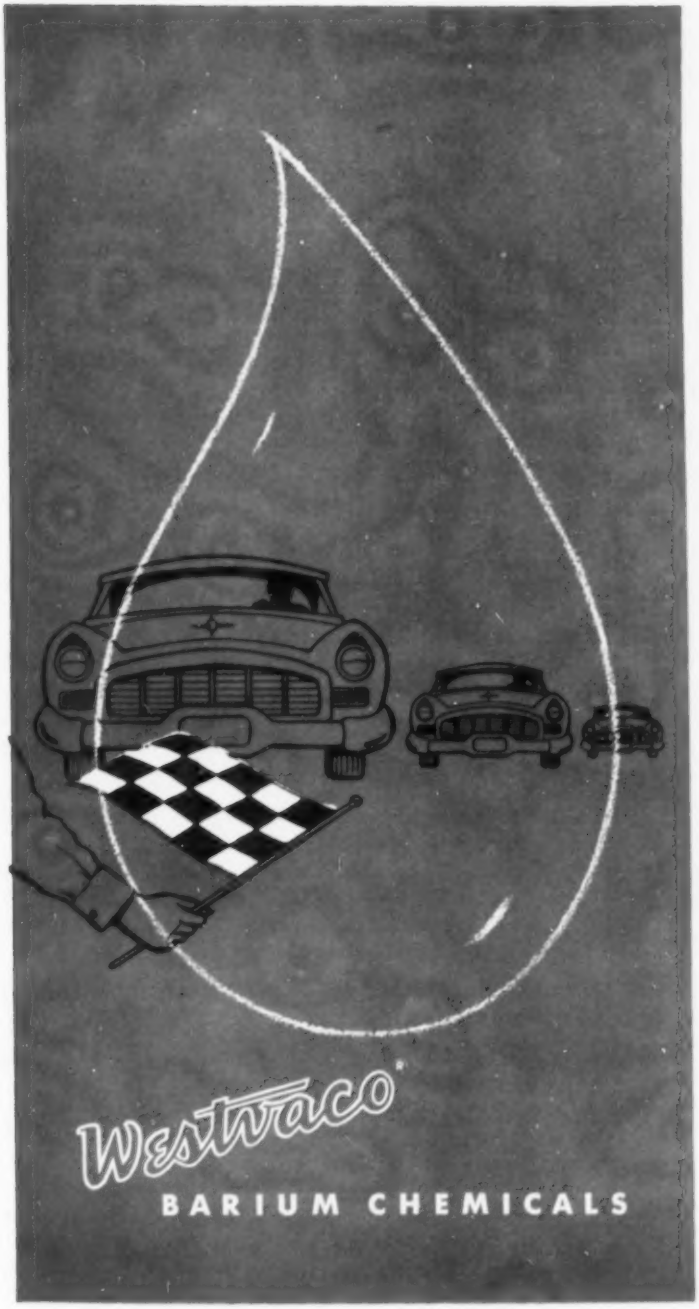


For further information, write for data sheets on "Drying of Gases." Address Dept. PE-9, Linde Air Products Company, A Division of Union Carbide and Carbon Corporation, 30 East 42nd St., New York 17, N. Y.

Linde
TRADE MARK
MOLECULAR SIEVES

The term "LINDE" is a registered trade-mark of Union Carbide and Carbon Corp.

Ba *laps the detergent additive field!*



Rising compression ratios in modern motor cars accelerate the lube oil industry's 3-to-1-and-growing preference for Barium Oxides as the basis of their detergent additives!

As the demand grows, Westvaco continues to anticipate it with expanded mineral reserves, increased electric furnace capacity and improvements in processing and customer service. Most important recent news was Westvaco's announcement that another 30% increase in output of Barium Oxide had been achieved as the result of an exclusive process developed by Westvaco engineers.

Whatever the future demand... we will continue to supply the industry's needs for Barium Oxide in dense, crystalline form . . . Barium Octahydrate and Barium Pentahydrate in soluble flake form.

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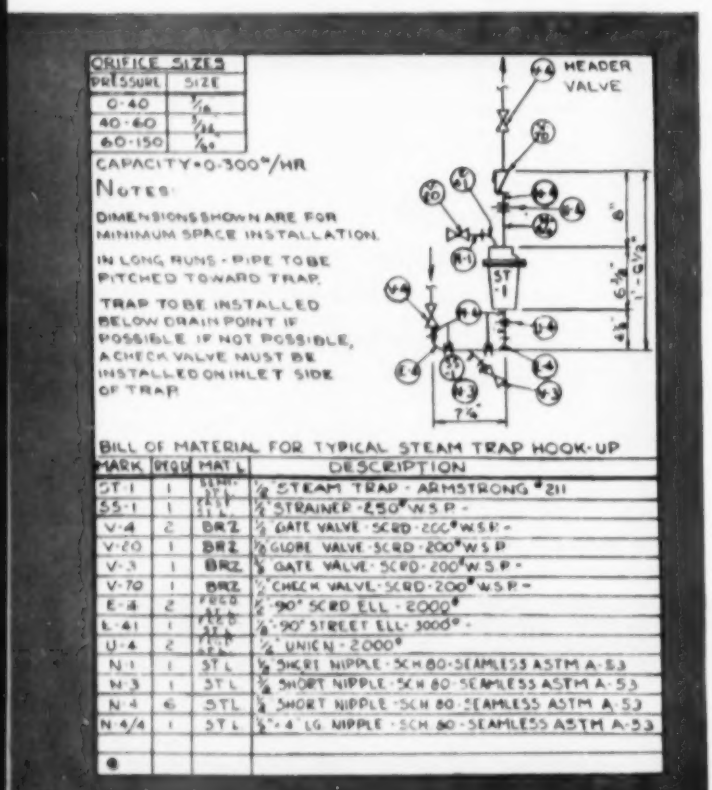
Steam Trap Standardization Slashes Trapping Costs

Major User Reports $25,000 Annual Maintenance Saving with 4000 Armstrong Traps

Here are the Benefits

- ***Quick Replacement of Traps*** **simply by uncoupling unions and installing a "spare" trap complete with nipples and half unions.**
- ***Bypasses Not Needed*** **—drain line can be shut off during quick trap replacement, even on critical equipment.**
- ***Repair Parts Inventory Reduced*** **by standardization on one make of trap.**
- ***Purchasing Simplified*** **through standardization.**
- ***Maintenance Men Become Experts*** **on one make of trap.**
- ***Armstrong Traps Last Longer*** **with less maintenance.**


ORIFICE SIZES
PRESSURE
SIZE
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40-60
60-150
CAPACITY-0-300#/HR
NOTES:
DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION.
IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP.
TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP
HEADER VALVE
ST-1
BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP
MARK | QTY | MAT'L | DESCRIPTION
ST-1 | 1 | | ½" STEAM TRAP - ARMSTRONG #211
SS-1 | 1 | | ½" STRAINER-250#W.S.P.-
V-4 | 2 | BRZ | ½" GATE VALVE-SCRD-200#W.S.P.-
V-20 | 1 | BRZ | ½" GLOBE VALVE-SCRD-200#W.S.P.
V-3 | 1 | BRZ | ½" GATE VALVE-SCRD-200#W.S.P.-
V-70 | 1 | BRZ | ½" CHECK VALVE-SCRD-200#W.S.P.-
E-4 | 2 | | ½" 90° SCRD ELL - 2000#
E-41 | 1 | | ½" 90° STREET ELL - 3000#-
U-4 | 2 | | ½" UNION - 2000#
N-1 | 1 | STL | ½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-3 | 1 | STL | ¾" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4 | 6 | STL | ¾" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4/4 | 1 | STL | ¾" - 4 LG NIPPLE - SCH 80 - SEAMLESS ASTM A-53

MAJOR REDUCTIONS in steam trap installation and maintenance work and cost can be achieved by standardization on one make of trap which, in turn, permits standardized hookups. For example, a major chemical company reports an annual maintenance saving of $25,000 since installing 4000 Armstrong traps according to the drawing and photographs shown here.

Traps of a Size Interchangeable

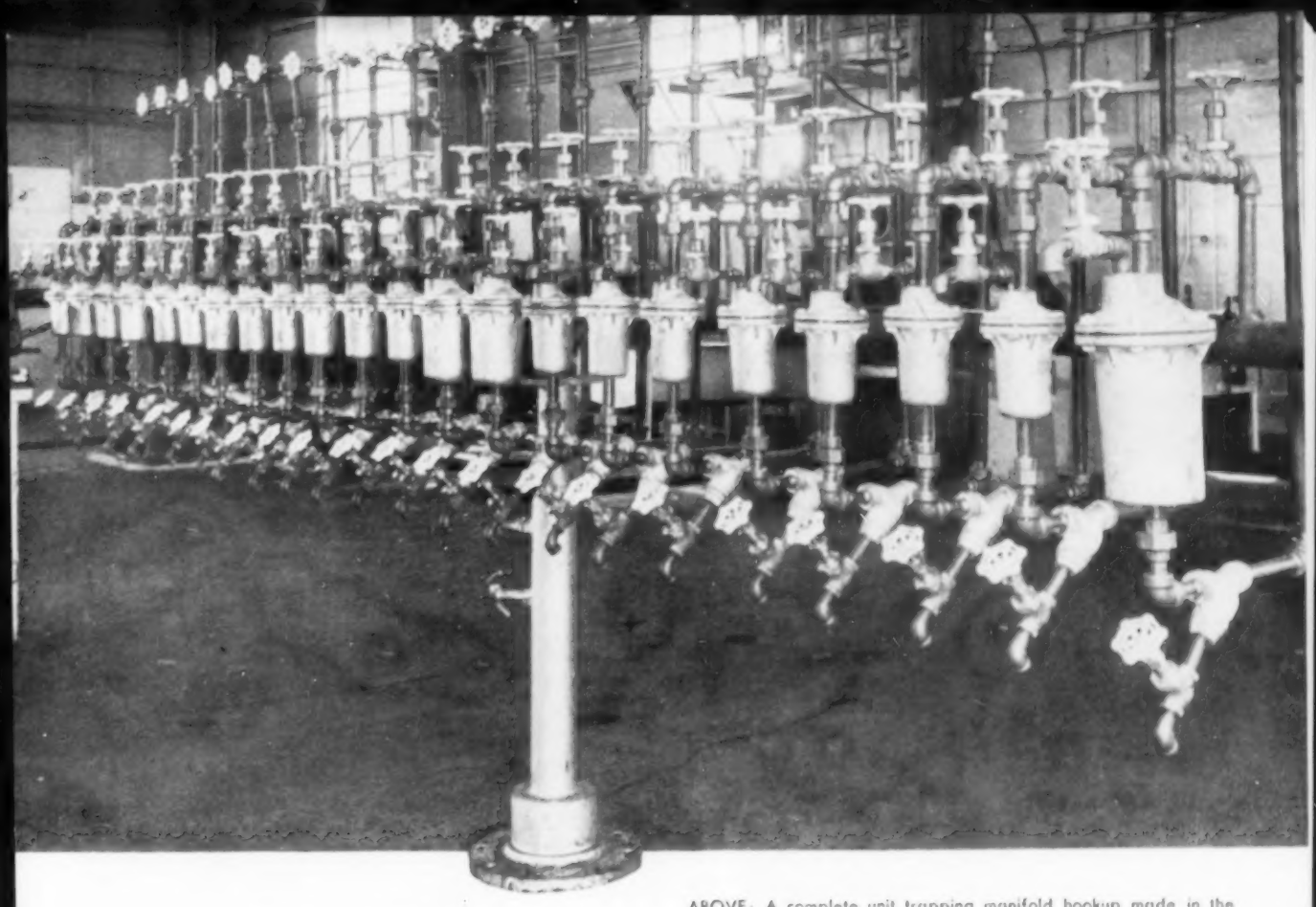
Note particularly that exact dimensions are given for the pipe fittings, including nipples, connected to each size of trap. When a trap needs repair, the unions can be uncoupled, the trap lifted from the line, and a "spare" carrying indentical length nipples and half-unions slipped in place. Thus, in as little as one or two minutes, a faulty trap is replaced. It is then returned to the storeroom for repair and takes its place as a "spare."

Additionally, each trap hookup offers the following time and cost-saving advantages:

1. Test valve in trap cap to permit fast, easy checking of trap operation so that any failure can be quickly detected to avoid waste.
2. Strainer ahead of trap to protect it against dirt and scale.
3. Blowdown valve in strainer to provide easy cleaning.
4. Check valve in discharge line to isolate trap when test valve is opened.
5. Shut-off valves and unions ahead of and following trap to permit removal of entire trap from line.

No Bypasses

Because of the rapid spare trap interchangeability, there is no need for bypasses to keep a unit in operation in event of trap failure. The cost of bypass installations is avoided, as is the waste that occurs when bypasses are in use, or accidentally left open. (Experience indicates that bypasses are often left open *not* due to trap failure, but due to reducing valve failure which allows steam pressure to exceed maximum trap operating pressure.)



ABOVE: A complete unit trapping manifold hookup made in the customer's piping shop. Note unions, shut-off valves, test valves and strainers for easy maintenance.

BELOW: Installation view of trapping hookup pictured above. All traps easily accessible for inspection and maintenance.

Condensate Headers

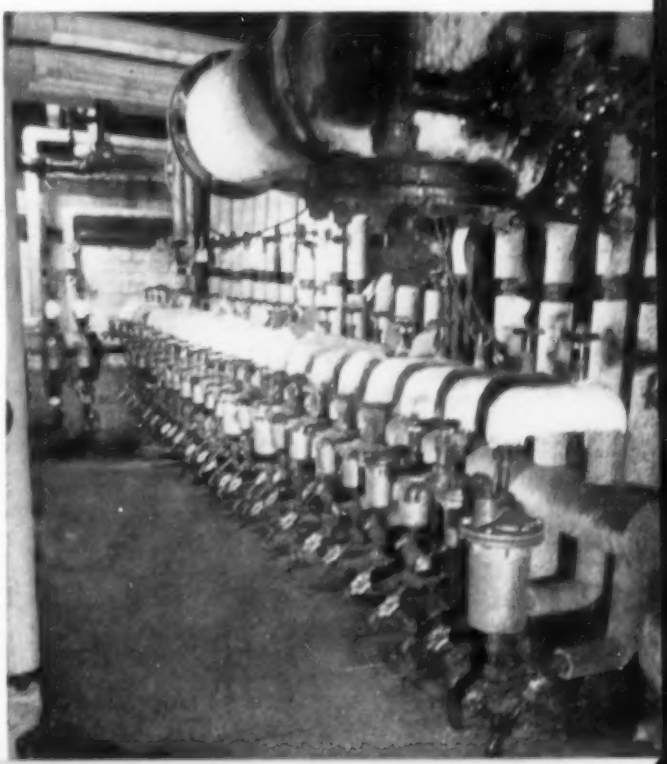
Another installation technique which saves installation and maintenance cost is the use, wherever possible, of trap manifolds. Traps and manifolds can be assembled in the plant pipe shop under ideal conditions for good workmanship and minimum time consumption. After assembly the manifolds are taken to the site of installation where lines from units in the vicinity are run to the traps. Traps are thus grouped where they can be found easily and where they are readily accessible for inspection and maintenance.

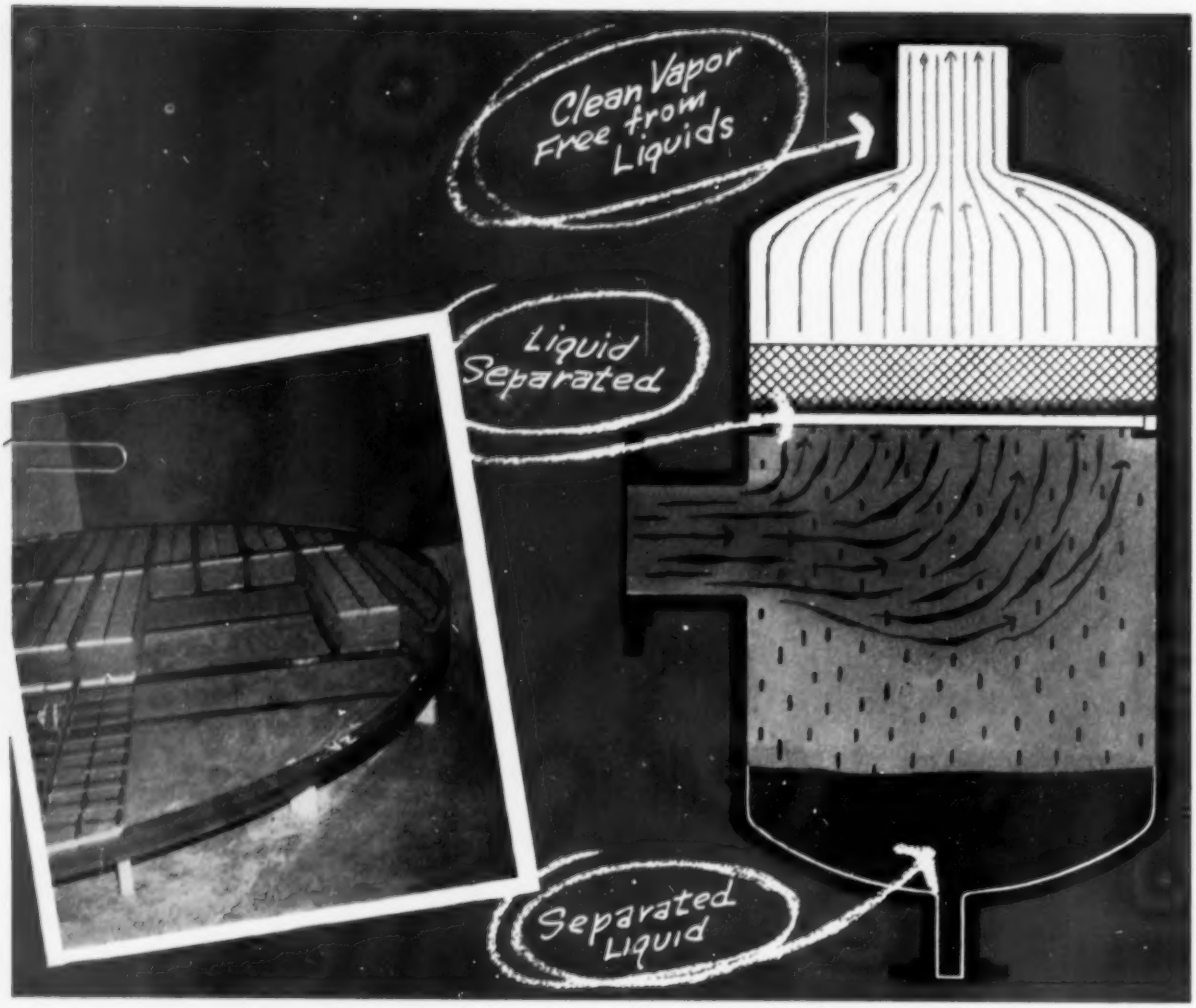
$25,000 Trap Maintenance Saving

Records kept on the Armstrong trap installation described here show that the cost of repair parts and complete replacement traps was approximately $10,000 less annually than with the traps previously used. Reduction in maintenance labor brings the total saving to $25,000 per year. *And fuel savings attributable to the traps are at least equal to the maintenance saving.*

FOR COMPLETE INFORMATION, ask for the No. 1, 1956 issue of the Armstrong Trap Magazine, together with a copy of the Armstrong Steam Trap Book containing complete data on Armstrong traps plus selection, installation and maintenance recommendations. Call your local Armstrong Representative or write:

ARMSTRONG MACHINE WORKS
826 Maple Street • Three Rivers, Michigan





How to IMPROVE Process Vessel PERFORMANCE

By effecting clean separation of liquid from vapor Yorkmesh Demisters improve process vessel performance.

In **distillation equipment** liquid entrainment is controlled, giving better quality overhead products even at increased thruput rates.

In refinery **vacuum towers,** higher quality gas oil means higher conversion rates to gasoline in the cat cracker.

In **absorbers,** loss of absorbing liquid is prevented.

In **separator vessels** and **knock-out drums** greater liquid recovery results.

In compressor **suction drums,** complete liquid separation decreases compressor maintenance.

In **evaporators,** by controlling liquid carry-over product loss is avoided, and high purity condensate is suitable for boiler feedwater or process use.

In **steam drums** the result is clean, dry steam.

In **vent stacks** Yorkmesh Demisters contribute to the solution of air pollution problems.

Write for Bulletin 17 and a complete list of the many case histories available from our technical library.

YORK

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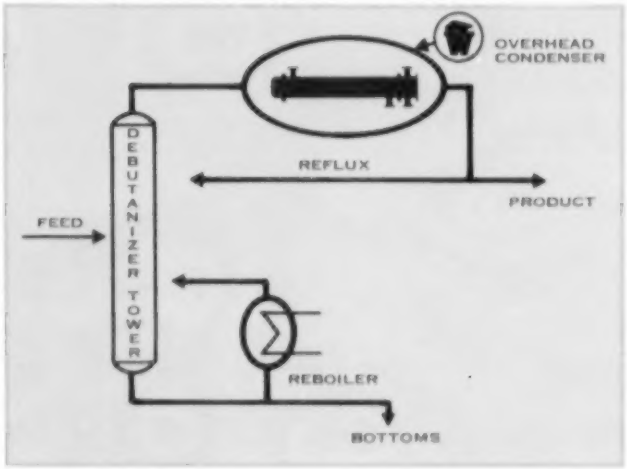
Specialists in FLUIDS SEPARATION / ENGINEERS and MANUFACTURERS

 (To obtain more data on advertised products see page 208)

Midwest Refinery Boosts Throughput 33%

- Integral finned condenser tube setting new heat transfer records
- Processing engineers take new look at extended surface condenser tube
- Roving reporter describes results of finned tube installations
- Manufacturer offers design information and operating data



by Ernest Dodd

During a recent swing through the major petro-refining areas of the Western States this writer was impressed by the amazing production records being established in plants using integral finned condenser tube. The tubing manufacturer is Wolverine Tube and the product is Wolverine Trufin® Type S/T.

Wolverine Trufin Type S/T

It's pretty hard, for example, to ignore a 33% increase in throughput, particularly when it was obtained simply by retubing an existing overhead debutanizer condenser. In describing this increase to me, the Chief Processing Engineer of a large Midwest refinery, declared that his plant's overall U had shot up from 140 to 210.

He also stated that in retubing, Wolverine Trufin was completely interchangeable with the formerly used prime surface tube. Exactly the same tools and standard tubing techniques were used. He was actually gleeful as he described how use of the integral finned tube increased the heat transfer surface area approximately 2½ times—*without any increase in unit size or weight.*

The principle of application of an extended surface tube to heat transfer problems has been well established for many years. However, its use in shell and tube condensers was not practical until Wolverine pioneered the use of integral finned tube. We predict that processing engineers in general are going to take a fresh look at this type of application as the good word spreads about the remarkable achievements of Wolverine Trufin Type S/T.

Design, Operating Information Obtainable From Manufacturer

Complete information on designing with extended surface tube, actual case histories and operating and fouling data are all described in a new Trufin Opportunity Book, according to an announcement by Wolverine Tube. The company maintains a Field Engineering Service for the assistance of any refinery or equipment fabricator considering the use of finned tube in heat transfer applications. Wolverine Tube's address is given below.

Wolverine Trufin is available in Canada through the Unifin Tube Co., London, Ontario

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WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO., LTD.
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WOLVERINE TUBE
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1141 CENTRAL AVE., DETROIT 9, MICH.

SURE-FIRE ANSWERS TO YOUR CONDENSER TUBE NEEDS

PRIME SURFACE TUBE

Wolverine manufactures prime surface tubing in copper, copper-base alloys and aluminum in a wide range of sizes.

DUPLEX PRIME SURFACE TUBE

Here's a tube designed to handle two types of corrosion simultaneously. It is composed of an outer tube of one metal and a liner of another. The combination can be of any two alloys you need to meet special corrosive conditions.

DUPLEX TYPE S/T

This tube also is designed for specific corrosive conditions. Like Trufin, it has integral fins—will boost heat transfer efficiency.

If you're looking for the answer to increased heat transfer efficiency, chances are you'll find it among the Wolverine condenser tubes described on this page.

Supposing, for example, that you're faced with corrosive attack on both shell and tube side. The right tube for you is Wolverine Duplex because it gives you an outer tube of one metal mechanically bonded to an inner liner of an entirely different metal. The combinations can be of any two alloys you need to stop corrosion in its tracks.

On the other hand perhaps you're concerned with a lack of space—would like to reduce your replacement tube inventory. In this case just specify Wolverine U-Bend condenser tubes—you'll not only reduce inventory but you'll also slash retubing time.

One metal or two—finned or prime surface—you'll find that Wolverine has done its level best to help you come up with the right answer. It's the type of program that comes from years of metalworking experience plus a thorough knowledge of an industry's needs.

And if you're not quite sure where your trouble lies, Wolverine's Field Engineering Service can help you. FES is a staff of highly trained tubing technicians skilled in matters of corrosion, alloy selection, design, or fabrication. For complete information just write for Wolverine's Condenser Tube Catalog. It's your's without obligation.

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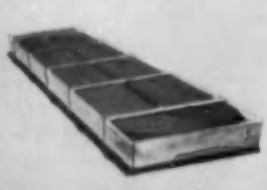


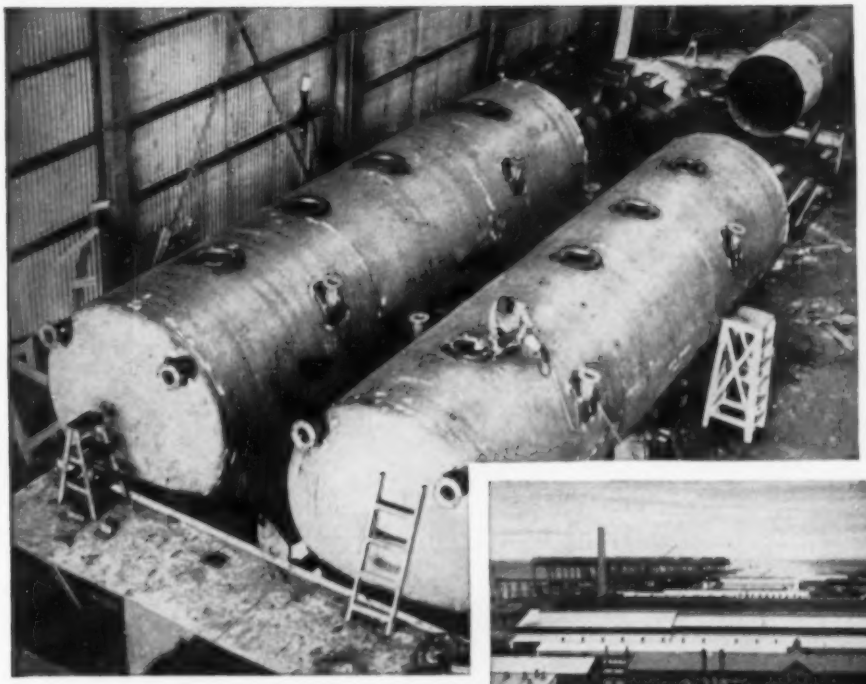
U-BEND PALLETS

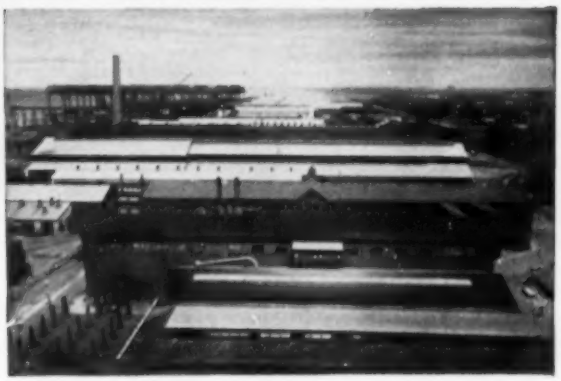
This new Wolverine idea cuts time, reduces storage problems and saves money. U-Bend condenser tubes—either finned or prime surface—are arranged in a disposable box-type pallet in the exact order you specify. All you have to do is feed them directly from pallet to unit.

FIELD ENGINEERING SERVICE

This is a Wolverine "extra"—a staff of highly skilled tubing technicians ready at all times to give you experienced help in problems dealing with alloys, corrosion, design or fabrication—and at no cost to you!

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
EXPORT DEPT., 13 E. 40th St., NEW YORK 16, N.Y.





A Mile of Shops – Each shop is devoted to a special type of heavy production. Included are complete Machine Shops, casting, forging and other facilities which offer all of the advantages of the execution of the complete job.

A half mile of pressure vessels

These are two of seventy – over ½ mile – of 38½-foot vacuum tank casings built to meet the quality requirements of a well-known processor.

The buyer also benefits from many savings made possible by Newport News extensive heavy fabrication equipment and the sixty years experience in using it.

Do you plan installations of heavy production equipment? You can command the services of Newport News for weldments of corrosion-resistant, alloy and clad metals in almost any size or shape, plus the required engineering background and complete welding and stress-relieving skills.

It will pay you to get the facts, shown in *Facilities and Products*. As you glance at its photos and brief captions, you'll see why Newport News can turn out – at low cost – specialized heavy equipment for process plants.

Send for *Facilities and Products* – free – today.

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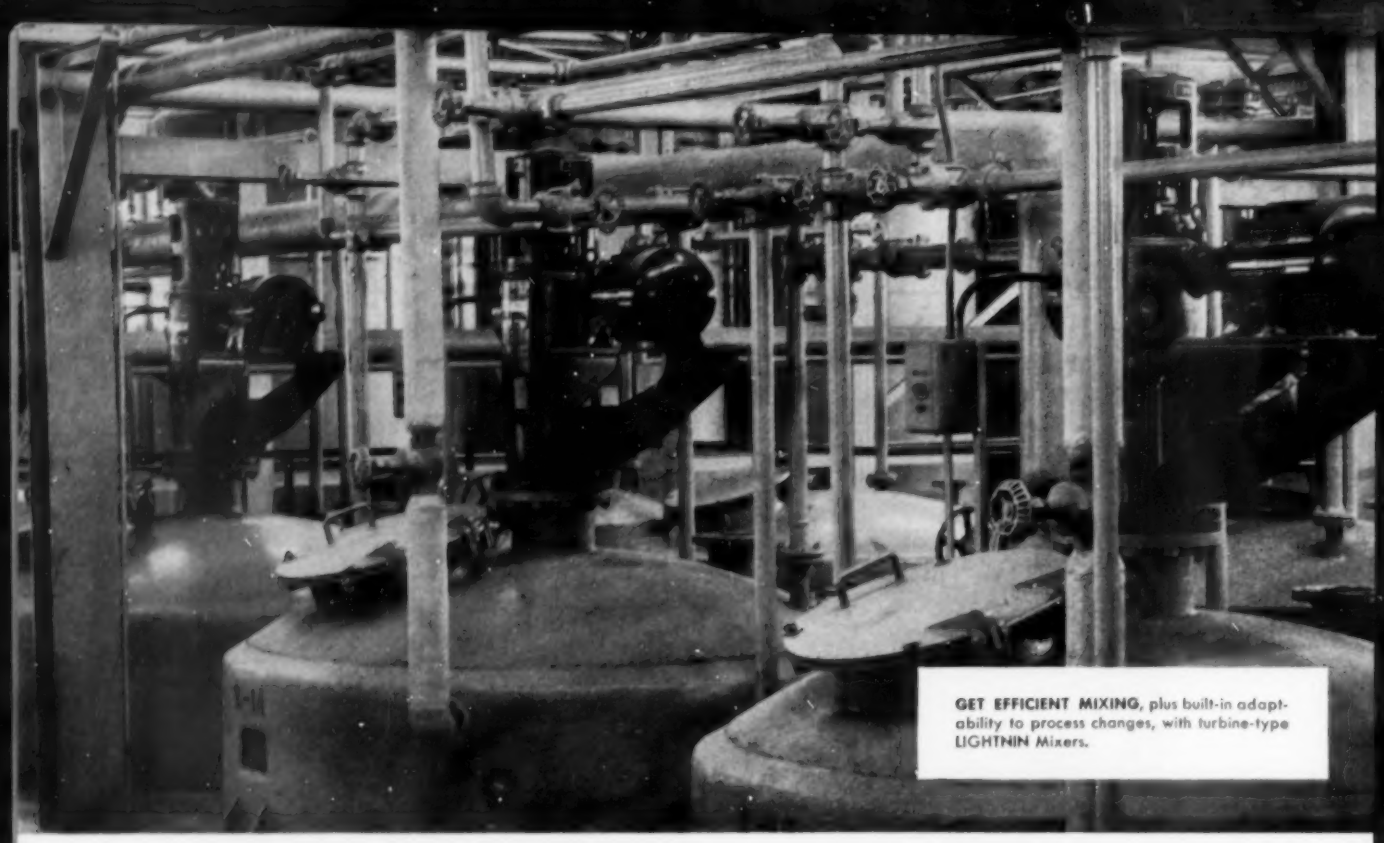

GET EFFICIENT MIXING, plus built-in adaptability to process changes, with turbine-type LIGHTNIN Mixers.

Use this **proved method** *to get good fluid mixing*

You can't afford to *guess* about fluid mixing. And you don't need to.

On any mixing operation you can get factual answers to questions like these, to guide you in your mixer selection:

1. What precise balance of *fluid flow* and *fluid shear* will do my mixing job best?
2. If this balance can be attained in different ways, what is the *most efficient* and economical way?
3. In scaling-up, does power required per unit volume remain constant? If not, by what factor does it increase or decrease?
4. Will the mixer transmit the required power to the mix, and do it efficiently?
5. Can the mixer be installed without special construction? Can I get standard replacement parts quickly if I ever need them?
6. Am I protected against mixer obsolescence in case of a process change?

You *know* the answers to these vital questions, when you mix with LIGHTNIN Mixers.

Predicting results

Even on the simplest mixer application, your LIGHTNIN sales engineer's recommendation is based on thousands of pilot runs, plus years of in-the-field experience.

On complex mixing jobs, pilot runs at MIXCO quickly find the impeller-to-tank diameter ratio and input power that will produce the optimum fluid regime most economically. Scale-up is *guaranteed accurate.*

Mechanical economy

Your mixer investment goes into equipment that is mechanically up-to-the-minute. Hundreds of *standard* LIGHTNIN power-speed combinations (interchangeable in many models); widest possible choice of in-stock materials and interchangeable components, give you assurance of correct application, smooth running, and flexibility when you need it.

For fluid mixing that does what you want it to do, call in your LIGHTNIN Mixer representative. (He's listed in Refinery Catalog.) Or write us direct.

GET LOWEST-COST MIXING, gasoline blending, suspension of BS&W in crude, with LIGHTNIN Side Entering Mixers. New rotary mechanical shaft seal ends stuffing-box repacking forever; stops leakage; runs for years without adjustment. Yet you can replace it in minutes if ever necessary.

"Lightnin® Mixers"

MIXCO fluid mixing specialists

FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

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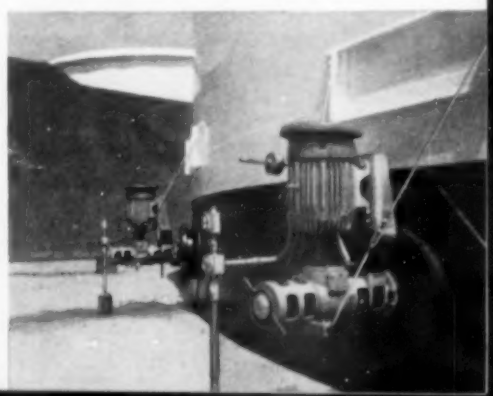
- ☐ B-103 Top entering; propeller types: ¼ to 3 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-104 Side entering: 1 to 25 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-110 Condensed catalog showing all types
- ☐ B-111 Quick-change rotary mechanical seals for pressure and vacuum mixing
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 131-J Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.



PETROCHEMICAL'S GROWING ROLE IN THE CHEMICAL WORLD*

	OUTPUT, billions of pounds					VALUE, billions of dollars				
	1954	1955	% Chg. '54-55	1956	% Chg. '55-56	1954	1955	% Chg. '54-55	1956	% Chg. '55-56
ALIPHATICS	15.8	19.8	+25.3	22.1	+11.6	2.33	2.77	+18.9	3.1	+11.9
AROMATICS	3.0	3.2	+ 6.7	3.6	+12.5	0.52	0.58	+11.5	0.66	+13.8
INORGANICS	7.7	9.0	+16.9	9.3	+ 3.3	0.32	0.36	+12.5	0.44	+22.2
TOTAL PETROS.	26.5	32.0	+20.8	35.0	+ 9.4	3.17	3.71	+17.0	4.2	+13.2
ALL CHEMICALS	114.6	134.8	+17.6	143.0	+ 6.1	6.04	7.22	+19.5	7.8	+ 8.0
PETROS. AS % OF ALL CHEMICALS	23%	24%	+ 4.3%	24.5%	+ 2.1%	52.5%	51.4%	− 2.1%	53.8%	+ 4.7%

*Product and value data are by Dr. R. L. Bateman, Director of Product Development, Carbide and Carbon Chemicals Co.

Petrochemicals

Forge Ahead Slowly

PETROCHEMICAL PRODUCTION in the U. S. in 1956 will climb to 35 billion lb, an increase of 9.40% over 1955 output, less than the nearly 21% output gain from 1954 to 1955.

Current year estimates reflect a leveling off in demand for synthetic rubber tires on new passenger cars in the early months of 1955—also less demand for synthetic ammonia and other agricultural petrochemicals.

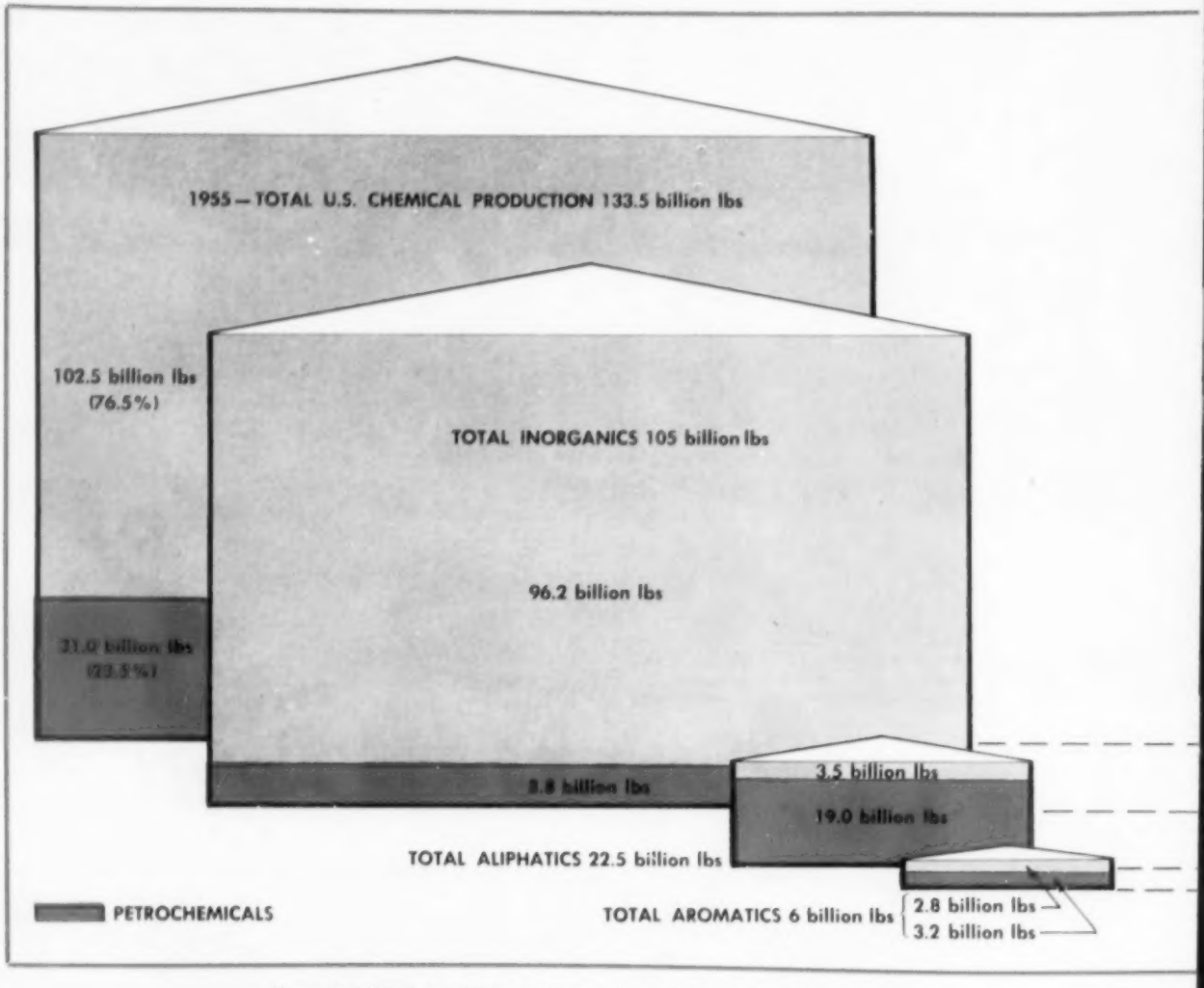
Petrochemical production for 1957 should show a greater rate of gain than this year, due principally to new gains in synthetic rubber and ammonia. Its growth over the two years 1956 and 1957 will be in line with the projected production of 60 billion lb by 1960 (see PETROLEUM PROCESSING, Sept. 1955, p. 1389).

These estimates come from studies of the growth in petrochemicals made by Dr. R. L. Bateman, Director of Product Development, Carbide and Carbon Chemicals Co., New York, which he has made yearly since 1947.

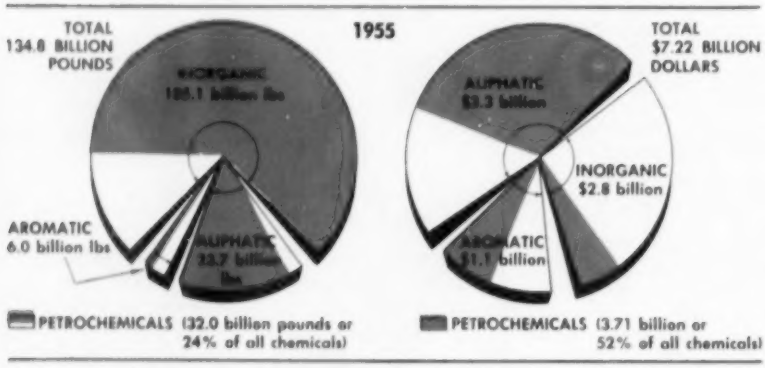
Chief impetus to the anticipated large growth in petrochemicals this year, and for some years ahead, will be the boom in plastics, Dr. Bateman believes. Starting from scratch in 1940 as a new industry, plastics materials

PETROLEUM PROCESSING's editors have completed their annual mid-year study of the Petrochemical Industry . . . here are the highlights:

- **1956 PRODUCTION** should increase about 9.4% over 1955 (appreciably less than 1955's climb of nearly 21% over 1954). Total 1956 production may reach 35 billion lb.
- **1957 PRODUCTION** increase over 1956 should exceed 1956's 9.4%. The projected 1960 production figure of 60 billion lb. still looks good.
- **SYNTHETIC RUBBER DEMAND** leveled off during 1955, as did demand for synthetic ammonia and other agricultural chemicals.
- **PLASTICS BOOM** continues to pace increased production, now about 3.5 billion lb/yr, and possibly 7.0 billion lb/yr by 1960.
- **PLASTICS MANUFACTURERS** eye home construction field as their best potential market.



Above charts based on preliminary data, and do not agree with charts below.



now take 3.5 billion lb of annual petrochemical production. By 1960 the use of petrochemicals for plastics will more than double, Dr. Bateman believes. Manufacturers of plastics and allied materials now take about 15% of the output of petrochemicals in a large number of products.

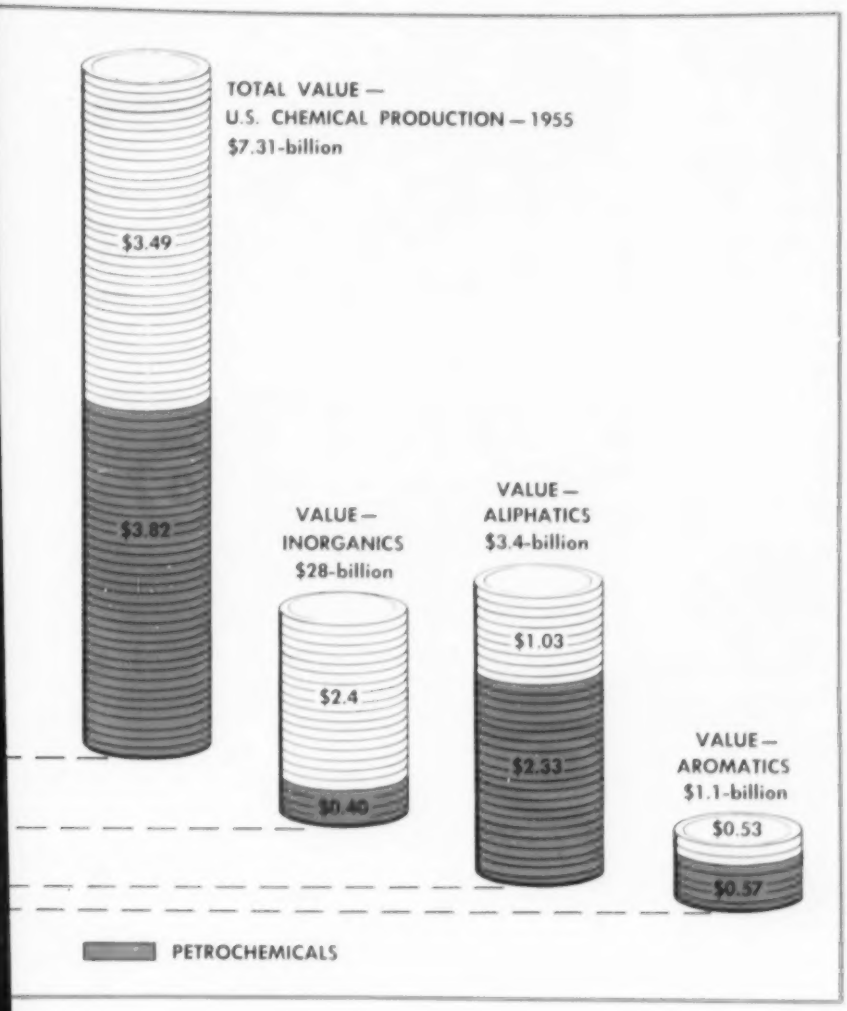
Oil companies and chemical concerns will heighten the plastics boom by introducing new processes for manufacture of petrochemical plastics. New processes announced by Phillips Petroleum Co. and Standard of Indiana for low pressure polyethylenes are examples of this trend.

Estimated 1956 output of 35 billion lb of petrochemicals is 24.5% of the anticipated total U. S. output of 143 billion lb of all chemicals this year. This latter will be a gain of 6.1% from the 1955 output of all chemicals of 134.8 billion lb, compared with an estimated 9.4% gain in petrochemicals.

All three classes of the chemicals derived from petroleum and natural gas hydrocarbons will show significant gains in output this year over 1955, Dr. Bateman believes.

Aromatics are expected to have the largest rate of gain, 12.5%. This reflects using part of the expanded U. S. catalytic reforming capacity for primary petrochemicals—benzene, toluene and xylenes. The estimated 1956 volume, 3.6 billion lb, of aromatic petrochemicals is still small compared with aliphatics and inorganics.

Aliphatics will contribute 22.1 billion lb to the total estimated petrochemical output in 1956. This repre-



sents a 11.6% gain from 1955 production.

Inorganics, principally recovered sulfur, synthetic ammonia and carbon black, will total 9.3 billion lb in 1956, an increase of 3.3% from 1955.

The value of total petrochemical output for 1956 is estimated at $4.2-billion, a gain of 13.2% from 1955. The value of petrochemicals, however, is over 50% of the estimated value of $7.8-billion for all chemicals produced in 1956.

Biggest rate of gain in product value will be in aromatics, 13.8% from a value of $580-million in 1955 to $660 million in 1956. An accompanying chart shows the relative proportion of product and value for the three classes of petrochemicals to all chemicals in 1955.

In his long range outlook, Dr. Bateman cites the development of new polymer type chemicals as one reason for anticipated petrochemical growth during the next decade.

Research chemists have long recognized, he points out, that many natural products have polymer structures, such as cotton, natural rubber, shellac, and so on. Years ago, chemists started to develop man-made polymers that would function as well as natural polymers.

Success in developing vinyl resin and synthetic rubber polymers stimulated further research, bringing forth new polymer-type petrochemicals with many superior qualities. Examples of this trend are epoxy resins and acrylic fibers.

Some of these new products have excellent bonding qualities, making it possible to bond plastics to metals to give longer surface wear. They may also be important in providing building materials. The dream of the plastics industry is the day when plastics will be used in home construction.

That plastics manufacturers regard the home construction field as their most important potential market was emphasized at the annual meeting of the Society of the Plastics Industry in New York this summer, featuring a plastic-built model home. Estimating home building at the rate of 1.5-million units a year from now until 1965, and at the rate of 2-million from 1965 to 1975, they point out that each structure is a potential market for already proven plastics applications, including wall coverings, flooring, upholstery, glazing, paneling, paints and other.

"To achieve effective penetration in the construction field," one authority stated, "the plastics industry has set its sights on an entirely new sphere of application—that of structural and semi-structural units. It is here that the most dramatic impact of plastics progress is anticipated. The influences that are today shaping the destiny of American housing all point to the increased use of plastics in tomorrow's building design."

Meet the Authority

Dr. Bateman

Dr. Robert L. Bateman's reports on current petrochemical production in the U. S., and on the growth trend of this relatively young but lusty industry, have been an exclusive feature of PETROLEUM PROCESSING's Petrochemical Number for the three past years.

Dr. Bateman, Director of Product Development, Carbide and Carbon Chemical Co., New York, started making these studies in 1947, when it was know as the "synthetic aliphatic industry." He has projected them annually since.

A native of New Jersey, Dr. Bateman studied at Ursinus College and received his M.S. and Ph.D. from the University of Pennsylvania, the latter in 1935. He joined the Organic Synthesis Fellowship of Carbide and Carbon Chemicals, at Mellon Institute, Pittsburgh, in 1935; and in 1937 was transferred to Carbide's Fine Chemicals Division in New York, becoming manager of the Division in 1944. In 1954 he was appointed to his present position.

The Synthetic Rubbers Are Hot

THESE ARE THE BIG ONES—S-type synthetic rubber above, Butyl on the facing page. Photo courtesy of U. S. Rubber, in whose Naugatuck Chemical Div. rubber sheeting is being worked

Not just today's big ones—

Butyl and S-type, but also the new dienes,

Neoprene, polyurethane, the silicones,

the polysulfide elastomers

and acrylic elastomers. And the "borderline"

materials—the rubberlike plastics.

What will all this mean?

Here's a deep and thorough analysis of today's

multi-sided synthetic rubber picture,

and its significance to petrochemicals tomorrow.

By B. H. WEIL
Huntington Woods, Mich.

SIXTEEN YEARS AGO, Government defense plans were beginning to breathe real life into the future of a rather wobbly infant industry—the production of the synthetic rubbers.

Fifteen years later—in 1955— this teen-age giant left his Government home to strike out for himself in a world of free enterprise.

Today, scarcely a year later, he has already established himself firmly on the industrial scene, and has added inches to his industrial capacity.

Tomorrow—by 1975, certainly—he seems likely to double or treble his stature. During this future growth to maturity, however, those who know him believe that at least part of his very make up will change in the process.

Synthetic rubber, today, is still almost synonymous with copolymers of butadiene and styrene—the so-called S-type of elastomers (the GR-S of the Government program) These elastomers have maintained or improved their status in competition with natural rubber because of their satisfactory or excellent properties for most uses; the ready availability of the petrochemicals needed for their manufacture; and their steady, usually lower prices.

Along with these S-type (general purpose) rubbers, growing quantities of specialty rubbers have continued to be used—Neoprene (polychloroprene), Butyl rubber (a copolymer of isobutylene and isoprene), and the N-type elastomers (copolymers of butadiene and acrylonitrile). United States consumption of all elastomers during 1947-55 is shown in Table 1. Moreover, according to the United States Tariff Commission, the 1955 domestic production of synthetic elastomers included 127,821,000 lb of polyvinyl elastomers (polyvinyl chloride, butyral, and alcohol) and 39,993,000 lb of "all other acyclic elastomers" (chlorinated and cyclo rubbers, polyurethane foams, and thiokol, silicone, polyisobutylene, and other acyclic rubbers).

On the horizon—not yet reflected in production statistics—are such po-

BUTYL RUBBER BEING HOT-ROLLED at Humble Oil and Refining Co., Baytown, Tex. Photo through courtesy of Standard Oil Co. (N. J.)

tential general-purpose rubbers as polyisoprene ("synthetic natural rubber") and polybutadiene, produced by new catalytic processes that are vast improvements over those of the past. These newcomers may very well upset the applecarts of any who have assumed that synthetic rubber will always be synonymous with the S-type elastomers.

It is highly significant that the present general-purpose synthetics rubbers (the S-types), the major specialty rubbers (Butyl, N-types, and Neoprene), and the highly-touted newcomers (polyisoprene and polybutadiene) are all produced by the polymerization of (or contain) diene hydrocarbon units —molecules containing a carbon-atom skeleton such as C=C—C=C, which yields chains containing the unit —C—C=C—C—. Chains of this latter type—like those in natural rubber—can then undergo vulcanization into commercial rubber products.

Some of the other important new elastomers, such as the polyurethane rubbers, are condensation products. They involve the condensation, chemical interaction, of such materials as glycols and polybasic acids, sometimes followed by interlinkage of chains. It is by no means certain, however, that the costs and availability of the chemical units involved will permit their competitive manufacture for general purposes—tires, mechanical goods, and the like. The chemical intermediates for these elastomers are actual or potential petrochemicals, but their synthesis is inherently more costly than that of most of the diene hydrocarbons. They will probably have to compete on the basis of superior quality.

This review will describe the current status of all these elastomers, including reported plans for the expansion of production facilities. It will briefly survey the types and production of petrochemical raw materials and intermediates, and will relate these developments to future competition with natural rubber.

S-TYPE RUBBERS

When private industry purchased the Government-owned plants last year, copolymer plants for the production of S-type elastomers had a net reported capacity of 857,600 long tons/yr. By the end of the year, however, changes made by the companies that purchased these plants brought the rated capacity to 915,000 long tons. As shown in Tables 2 and 3, moreover, plant expansions announced for completion by the end of 1957 may bring this capacity to 1.2 million long tons or more. In recent years, incidentally, prices have approximated 23¢/lb., fob plant.

The S-type of elastomers are copolymers of butadiene and styrene, reacted together in such proportions that the resultant copolymer usually contains 23.5% of bound styrene. Emulsion polymerization is employed; i.e., the butadiene and styrene are first emulsified with sodium fatty-acid soaps (sometimes also containing rosin). The catalysts usually involved

Table 1—United States Consumption of Rubber, 1947-1955

(Thousands of long tons)

Year	Total New Rubber	Natural Rubber Tons	Natural Rubber Percent	Synthetic Rubber S-Type	Synthetic Rubber Neoprene and N Butyl	Synthetic Rubber Neoprene and N Type	Synthetic Rubber Neoprene and N Total	Reclaimed Rubber Tons	Reclaimed Rubber Ratio to New Rubber
1947	1,122.3	562.7	50.1	448.6	68.8	42.2	559.6	288.4	25.7
1948	1,069.4	627.3	58.7	345.3	58.9	37.9	442.1	261.1	24.4
1949	988.9	574.5	58.1	321.1	52.7	40.6	414.4	222.7	22.5
1950	1,258.5	720.3	57.2	416.2	66.3	55.7	538.2	303.7	24.1
1951	1,214.3	454.0	37.4	627.8	70.5	62.0	760.3	346.1	28.5
1952	1,261.4	453.8	36.0	667.0	71.2	69.4	807.6	280.0	22.2
1953	1,338.3	553.5	41.4	624.2	77.8	82.8	784.8	285.1	21.3
1954	1,233.0	596.3	48.4	500.3	61.5	74.9	636.7	249.0	20.2
1955	1,529.7	634.8	41.5	742.0	54.0	98.9	894.9	312.8	20.4

Source of data: see Reference (2).

Table 2—Producers of and Announced Capacities for S-Type Synthetic Rubbers

Company	Location	Announced Capacity (Long Tons/yr.) Initial	Expanded
American Synthetic Rubber Corp.	Louisville, Ky.	44,000	68,000
Copolymer Rubber & Chemical Corp.	Baton Rouge, La.	49,000	68,800
Firestone Tire & Rubber Co.	Akron, Ohio	30,000	40,300
	Lake Charles, La.	99,600	149,600
General Tire & Rubber Co.	Odessa, Texas	—	40,000
Goodrich-Gulf Chemicals, Inc.[1]	Institute, W. Va.	122,000	122,000
	Port Neches, Texas	90,000	95,000
Goodyear Synthetic Rubber Corp.	Akron, Ohio	15,200	15,200
	Houston, Texas	99,600	149,600
Phillips Chemical Co.[2]	Borger, Texas	63,000	108,000
Shell Chemical Corp.[3]	Los Angeles, Calif.	89,000	110,000
Texas-U. S. Chemical Co.[4]	Port Neches, Texas	88,000	135,000
United Rubber & Chemical Co.	Baytown, Texas	44,000	44,000
United States Rubber Co.	Naugatuck, Conn.	22,200	22,200
Total		855,600[5]	1,167,900[6]

[1]50% owned by Gulf Oil Corp.
[2]100% owned by Phillips Petroleum Co.
[3]100% owned by Shell Oil Co.
[4]50% owned by The Texas Co.
[5]Not including 2,000 long tons of annual capacity already in private hands before 1955.
[6]Additional planned expansions have evidently been reported to the Government but not yet publicly announced, because end-1957 capacity for S-type rubber is expected to be 1,272,100 tons.

Table 3—Reported Plans for Expansion of Facilities for Producing Synthetic Rubber, 1956-59, Compared with Actual 1955 Capacity

(Thousands of long tons)

End of:	S-Type Net	S-Type Net Plus Oil	Butyl	Neoprene	N-Type	Net	Net Plus Oil
1955	915.0	1,029.9	90.0	100.0	40.8	1,145.8	1,260.7
1956	1,031.9	1,181.0	90.0	125.0	63.9	1,310.8	1,459.8
1957	1,272.1	1,435.8	90.0	125.0	67.4	1,554.5	1,718.2
1958	1,273.1	1,436.8	90.0	125.0	68.1	1,556.2	1,719.9
1959	1,285.1	1,448.8	90.0	125.0	70.6	1,570.7	1,734.4

Source: see Reference (2).

are of the persulfate type (for "hot" polymers) or hydroperoxide type (for "cold" rubber); sugar-free iron activators are also employed in the latter case. Polymerization is continued to the desired point (from 60 to 72% of completion), then shortstopped with hydroquinone or a carbamate.

Excess butadiene and styrene are respectively flashed and stripped from the latex, and subsequently recovered. An antioxidant (plus perhaps oil or carbon black) is added, and the synthetic-rubber latex is coagulated by addition of sulfuric acid and sodium chloride (salt) brine, which are then filtered off. Residual amounts of these agents and soluble polymerization chemicals are then removed by washing; following drying, the moisture-free rubber is packaged for handling, storage, and shipment.

The S-types of elastomers are handled in rubber processing (molding, extrusion, coatings, etc.) very much as is natural rubber, although different proportions of compounding ingredients are employed, as well as different times and conditions of milling, etc. The S-type rubbers are much more dependent than natural rubber upon the addition of carbon black to yield stocks of high tensile strengths. Other compounding ingredients include softeners (such as moderately heavy petroleum distillates), tackifiers, vulcanizing agents (chiefly sulfur), accelerators, and activators and retarders.

While the Government program included much research on and limited production of a large number of variants of the standard S-types, through variations in the proportion of reactants, types of polymerization agents, etc., only a few basic types are currently in large-scale production by private producers. These include S-type "hot" and "cold" rubbers, oil-extended rubber, black masterbatches, and latex.

"Hot" and "Cold" Rubbers. The S-type of rubber originally produced by the Government was what is now known as the "regular" or "hot" copolymer—produced at a temperature of 120°F or above. These high temperatures were needed to obtain reasonable reaction rates. It was known that the use of lower temperatures would yield a better quality of product, but excessive reaction times were involved

In the postwar period, however, the development of processes based on German "redox formulas" made possible the economic operation of plants at 41°F, with production of an elastomer, which, when properly compounded with newly developed furnace blacks, is not only superior to regular GR-S, but is even better than natural rubber in such applications as passenger-tire tread stocks. This "cold rubber" accounted for nearly 70% of production in 1955, and additional capacity is being installed.

Oil-Extended Rubber. In 1950, when the output of synthetic-rubber plants was being severely taxed, discoveries indicated that it would be possible to extend the capacity of existing plants by adding 25 to 37.5 wt-% of naphthenic or aromatic oils to the synthetic latex, prior to coagulation, to produce what are known as "oil-extended" rubbers. Addition of oil at this point permits the use of a latex polymerized to a higher molecular weight and viscosity (with accompanying improved properties) than could otherwise be readily processed on rubber-compounding equipment. The oil softens and plasticizes the tougher polymer, making it as easy to process as conventional S-types. The resultant oil-extended rubber may then be treated as if it were 100% rubber in subsequent compounding. As mentioned, the use of oil in this manner effectively extends the capacity of the equipment so employed; This may be noted in Tables 1 and 3.

Oil extension is normally applied to cold rubber as the base polymer. The use of naphthenic oils (up to 25%) yields copolymers that do not process as well as those containing highly aromatic oils; however, products containing naphthenic oils exhibit better resistance to staining and discoloration, and are thus more readily adaptable to the production of tires, floor tile, shoe soles and heels, etc. Where color is not an important consideration, larger quantities (up to 37.5%) of highly aromatic oils can be employed, with resultant economies.

Black Masterbatching. Carbon blacks may also be added in slurry form (50 parts of black by weight to 100 parts of polymer) to S-type elastomers at the latex stage, prior to coagulation, with important savings in time and power during later milling. Both carbon blacks from natural gas and oil blacks are being employed by various companies. Production of black masterbatches during the latter part of 1955 amounted to approximately 10% of the total output of S-type rubbers.

Black masterbatches can also be oil-extended. When this is done, the total oil plus copolymer is considered as "apparent" polymer, so that a typical oil-extended black masterbatch might include 100 parts of cold S-type polymer, 37.5 parts of aromatic oil, and 68.75 parts black.

Latex. As is well known, the present method of emulsion polymerization of butadiene and styrene to produce the S-type rubbers yields a synthetic latex as an intermediate. This is normally coagulated to solid rubber, but it may instead (sometimes with minor modifications in butadiene-styrene ratio) be used as such, or concentrated by heat to provide a high solids content—60-63%, for example. These latices are suitable for a variety of applications, including latex-based sizes for the undersides of carpets and rugs, adhesives, dips for tire cords and conveyor belts, adherent bases for textile sizes and finishes, and—most importantly—foam-rubber products.

The consumption of all types of rubber latices rose from 132,000 long tons in 1954 to 160,000 long tons in 1955. More than a proportionate increase was displayed by the S-type latices—from 33% of domestic latex consumption in 1954 to 38% in 1955. In that year, S-type latices were produced by six companies.

NEOPRENE

Neoprene, the first of the commercial synthetic rubbers (introduced in 1931), continues to find considerable use as a specialty rubber because of its superior properties (compared to natural and S-type rubbers) as regards

Synthetic Rubber Today Is a Many-Sided Material

Today's Synthetic Rubbers	...Their Chemical Derivation	...Their Principal Uses	...1955 Production
S-Types	Copolymers of butadiene and styrene	Tires, mechanical goods, other general purposes.	775,000 long tons
N-Types	Copolymers of butadiene and acrylonitrile	Products requiring oil heat, or chemical resistance.	32,000 long tons
Butyl	Copolymers of isobutylene and isoprene	Inner tubes, mechanical goods requiring impermiability to gases.	55,000 long tons
Neoprene	Polymer of chloroprene (from acetylene and HCl)	Products requiring resistance to aging, oil, or chemicals.	55,000 long tons
New Diene Types	Polymers of isoprene or butadiene. Polyisoprene is synthetic "natural" rubber.	Truck and bus tires; other natural-rubber products requiring toughness; insulation, belting, golf-ball covers.	Pilot-plant stage
Polyurethanes	Made by increasing the chain length of polyesters or polyethers through linking the molecules with diisocyanates	Rigid or flexible foams, useful in shoe soles, gaskets, crash pads, pillows, mattresses, furniture. The potential "100,000-mile" tire material.	2,000 long tons
Silicones	Chlorosilane intermediates (from metallic silicon and methyl or aryl chlorides)	High-temperature caulking and gaskets, high-pressure steam service, food conveyor belts, engineering materials.	*
Polysulfide Elastomers	Reaction products of organic dichlorides and alkali polysulfides	Gasoline hose, printing rolls, bullet-proof airplane tank liners.	*
Acrylic Elastomers	Derived from ethylene chlorohydrin or acetylene	Products requiring high-temperature oil or aging resistance.	*

*1955 production of starred items totalled 16,000 long tons including polyisobutylenes and chlorosulfonated polyethylene. About 57,000 long tons of other elastomer-like materials, certain vinyl resins, were also produced in 1955.

oxidation, weathering, flame resistance and, particularly, resistance to petroleum oils and chemicals. It is a polymer of chloroprene, made from acetylene and hydrogen chloride.

At the end of 1955, the production capacity for Neoprene was 100,000 long ton/yr, 15,000 greater than at the end of 1954. Capacity is expected to reach 125,000 in 1956; no further increase is anticipated at present. Plant operations until this year were conducted entirely at Louisville, Kentucky; the new capacity results from the announced construction of a Neoprene plant at Montague, Michigan.

N-TYPE RUBBERS

The N-type ("nitrile") elastomers, copolymers of butadiene and acrylonitrile, are characterized by superior oil and chemical resistance, ease of processing, excellent physical and electrical properties, and high heat resistance. Obviously, they compete with Neoprene (and some of the newer synthetics) for uses where these properties (especially oil resistance) are important—in automobiles, in petroleum industry applications, in chemical industry uses, etc.

Plant capacity for the production of N-type rubbers increased from 25,000 long tons at the end of 1954 to 40,800 long tons at the end of 1955. Further increases are planned.

The manufacture and sale of N-type elastomers is conducted by Firestone Tire & Rubber Co. (Butaprenes), B. F. Goodrich Co. (Hycar OR's), Goodyear Tire & Rubber Co. (Chemigums), and U. S. Rubber Co. (Paracrils—formerly Perbunans).

BUTYL RUBBER

As is common knowledge, Butyl rubbers—copolymers of isobutylene and isoprene (both petroleum derivatives)—are an American development based on knowledge of the rubberlike qualities of polybutylenes. Since the latter cannot be vulcanized, however, because they lack the chemical unsaturation present in natural rubber and in the other elastomers so far discussed, it was a logical (but brilliant) extension to intersperse in the long chains of carbon atoms a few molecules of a disolefin such as isoprene, to the extent (1.5 to 4.5%) that would render the copolymer vulcanizable, yet thereafter essentially saturated and less prone to oxidation and other chemical attack (acids, inorganic salts, etc.). Other distinguishing properties of Butyl rubbers are their phenomonal impermeability to the passage of gases (hence their use in innertubes), and their good tear resistance after aging and at elevated temperatures.

The domestic consumption of Butyl rubber has been slowly declining since 1953, chiefly because sales of tubeless tires have cut into the market for Butyl rubber innertubes (formerly the chief use, because of Butyl's impermeability to gases). Much research is being conducted on an all-Butyl tire said to have exceptional wearing qualities and air-retention properties, and on applications in mechanical goods, fabric-coating, and electrical-insulation fields. One 1956 make of car, for example, is said to have Butyl parts (shock absorbers, window seals, radiator hose, foot-pedal covers, etc.) which require twice the amount

of Butyl rubber formerly needed for five innertubes. Butyl rubber may very well become a general-purpose rubber instead of a specialty elastomer.

Butyl rubber was the "GR-I" of the Government program, and, although privately developed, the two large-scale plants for its manufacture were Government owned until March, 1955. At that time, the plant at Baton Rouge, Louisiana (capacity: 47,000 long ton/yr) was purchased by its operator, Esso Standard Oil Co., and the plant at Baytown, Texas (capacity: 43,000 long ton/yr) was bought by its operator, Humble Oil & Refining Co. (a New Jersey Standard affiliate). Until April, 1958, Esso is under obligation to sell the Baton Rouge facility to any bona fide purchaser unless Butyl-rubber-producing facilities of at least 43,000 long tons of aggregate annual capacity have been substantially completed in this country prior to the receipt of such an offer.

Enjay Co., Inc. (another Jersey Standard subsidiary) has been the exclusive sales agent for the output of both Butyl rubber plants. Licenses to Butyl rubber patents were obtained by B. F. Goodrich Co. (1950), Goodrich-Gulf Chemicals, Inc. (1953), and Petroleum Chemicals, Inc. (1954), but prior to the end of 1954 none of these groups had reportedly accepted subsequent supplemental Butyl licenses offered by the Esso group.

However, a recent new items states that Thiokol Corp. is planning to market Butyl rubber; is establishing a sales, research, and development laboratory at Trenton, N. J., for this purpose; and is being helped to enter this field by Petroleum Chemicals, Inc. (a Butyl-patent licensee, as noted above). If this market-development program is successful, Petroleum Chemicals, Inc., will reportedly build a $25-million Butyl plant at Lake Charles, La. These plans, being recent and only tentative, are not reflected in Table 3.

THE NEW DIENE RUBBERS

In 1955 and 1956, many news accounts reported stages in the development of new-type polyisoprene and polybutadiene synthetic rubbers. At least four companies have announced work on such elastomers—Firestone Tire & Rubber Co. ("Coral rubber," a polyisoprene), Goodrich-Gulf Chemicals, Inc. ("Ameripol SN," a polyisoprene), Goodyear Tire & Rubber Co. (a polyisoprene), and Phillips Petroleum Co. (both a polybutadiene and a polyisoprene).

What distinguishes these elastomers from those prepared over the years by either bulk or emulsion polymerization of the same ingredients—isoprene or butadiene—is the use of new catalysts that cause polymerization of the molecular units in essentially a straight-chain, end-to-end (1, 4-) manner, similar in structure to the molecules in natural rubber. The catalysts employed are even more specific in behavior than this; they cause production of the natural-rubber-type *cis* polymers—polymers whose diene-molecule units have a geometrical configuration in which groups are on the *same* side of a plane.

Modifications of at least some of these processes can yield *trans* ("*opposite* side of the plane") polymers. These are possibly economic synthetic counterparts to gutta-percha and balata (used in insulation, belting, and golf balls, where toughness is important). Lack of selectivity in previously-known catalysts had always before caused the synthesis of elastomers that were inferior in properties and handling characteristics to natural rubber or the S-type synthetic products.

Interestingly enough, several different catalysts are apparently being employed, although all methods resemble one another by being "bulk" processes, using solid-surface catalysts and liquid-solid-phase reactions instead of the soluble catalysts and emulsion-type reactions employed for the S-type commercial rubbers. Goodyear uses a "catalyst similar to one discovered in Europe for making polyethylene plastic"—perhaps similar to the metal alkyl-metal halide catalysts reportedly employed by Ziegler and Natta for low-pressure polymerizations of the lower olefins and diolefins. Firestone uses a 35% dispersion of fine particles of lithium metal in petroleum jelly, at 30-40°C. Goodrich-Gulf reportedly employs "catalyst systems based on polyolefin information purchased from Karl Ziegler." The Phillips catalyst has not been announced, but this company has developed its own low-pressure process for polymerization of ethylene and other olefinic hydrocarbons.

The Polyisoprene Rubbers being developed by all these companies are apparently almost identical to each other and to natural rubber in structure (*cis*-type polymers) and properties. At elevated temperatures such as those encountered in truck tires, these synthetic elastomers (like natural rubber) have two to four times the strength of the S-type synthetics. Heat build-up is about half that of the S-type elastomers, and equivalent to that of natural rubber. Other properties differ slightly from those of natural rubber; some are better, a few not quite as good.

While the S-type elastomers give excellent service in passenger-car tires, they are not completely satisfactory for use in all truck- and bus-size tires, because these must withstand the higher temperatures developed by running with heavy loads for long distances. Natural rubber has had a decided advantage here, until now. Hence all the excitement over these new polyisoprenes, whose commercial availability would relieve this country of wartime dependence upon foreign sources of natural rubber. Large-scale tests of large-size polyisoprene tires in their present state of development have already yielded mileages ranging from 95 to 120% of those obtained under comparable conditions with natural-rubber bus and truck tires.

It is anticipated that the polyisoprenes can be produced commercially for slightly over 30¢/lb, based on isoprene at 20-30¢/lb. An 18¢/lb price for the latter is not impossible, however. At 30¢/lb, the polyisoprenes would be competitive with natural rubber at most of the prices that have prevailed in recent years. While the latter can be grown efficiently at 12-15¢/lb, as will be discussed later, proponents of the polyisoprenes stress ready availability in wartime, and the possibility of steady contract prices (as contrasted with violent fluctuations in the market price of natural rubber). For those specific applications where natural rubber at present has advantages—truck and bus tires, for example—polyisoprenes at 30¢/lb would be competitive with the S-type elastomers at 23¢/lb.

Production of the polyisoprene rubbers has so far been conducted on a pilot-plant scale at least by Firestone and Goodrich-Gulf. One news report states that the latter began construction, late in 1955, of a "commercial-scale" plant at Avon Lake, Ohio, scheduled for completion sometime this year. This news item may well be in error, however, because late last year Goodrich-Gulf announced a pilot plant for the same location and with the same construction schedule. In any event, really-large-scale production of polyisoprene rubbers is at least a few years off.

Polybutadiene Rubbers. Most of the information available on polybutadienes stems from the Phillips Petroleum Co., whose *cis*-1, 4-polybutadiene "gives promise of providing

an economical alternate for natural rubber in many of its uses." Tests indicate that Phillips' polybutadiene "runs 20°F cooler" than S-type cold rubber, is 10-15% more resilient, and has a freezing point of about —160° F, some 90° better than the S-type elastomer; i.e., it "performs better at low temperatures." *A trans*-1, 4 polymer, produced by a modification of the Phillips process, is "a high-softening-point (greater than 300°F) resin with many potential uses."

Experiments on the synthesis of similar polybutadienes have reportedly been conducted by Giulo Natta and others. No plans have yet been announced for commercial production of polybutadienes by any company. However, some rubber experts reportedly feel that polybutadiene (based on butadiene at 14¢/lb) has better possibilities than polyisoprene for "bigger markets and profits."

MISCELLANEOUS ELASTOMERS

As noted earlier in this article, there are now a considerable number of elastomers that compete with the S-type (general-purpose) and specialty rubbers (Neoprene, N-type, and Butyl) for a growing number of applications. Such uses are usually based on superior properties that compensate for higher costs of their chemical intermediates. Some of these elastomers, in fact, have such outstanding properties that they may very well grow rapidly in production and eventually cut into the potential markets for the general-purpose rubbers.

Polyurethane Rubbers. If a 100,000-mile tire is ever commercially marketed, odds are at present that it will at least have a polyurethane tread. These rubbers are prepared by first producing polyesters, polyethers, etc., and then increasing the chain lengths of these resinous condensation products (necessary to develop good rubbery properties) by linking molecules together with diisocyanates. In other words, they are diisocyanate-linked condensation elastomers.

Depending on the exact diisocyanates and polyesters (or polyethers) and the proportions of those employed, plus the catalysts used, the polyurethanes currently available vary in nature from flexible or rigid foams to solid products resembling hard rubber. The flexible foams are said to be more uniform than similar natural-rubber foams, and also lighter, more tear resistant, harder to wear out, and more acid resistant. Rigid foams have high compression strengths and excellent adhesion qualities; the liquid ingredients may be poured into thin-wall shells (such as the structural skin of an airplane) and foamed there into a rigid, adherent block that insulates and adds structural strength.

The solid forms of polyurethanes have found application in oil seals, gaskets, special gears, heavy-duty soles and heels—places where excellent abrasion resistance and imperviousness to oil are required. They have been used experimentally as thin treads on tire carcasses.

While production of the polyurethanes (also called isocyanates and polyester foams) approximated only 3-4 million lbs. in 1955, annual capacity scheduled for completion this year will exceed 40-million lb, and 1960 consumption for foams alone is predicted at 100-million lb (out of a total predicted foam-rubber consumption of 500 to 600-million lb). Chemical companies (DuPont, Mobay, and National Aniline) are among the most active manufacturers, at present, but the rubber companies are also involved, at least in research —Goodyear with its Chemigum SL, and Goodrich and U. S. Rubber with their own products (both have Bayer licenses).

The sales appeal of 100,000-mile passenger tires does not appear particularly high, at present, but a good market for long-wearing tires might be the users of truck, bus, and aircraft tires. At present, some 300,000 long tons of all kinds of rubber are consumed annually in their manufacture, so experimentation in the field of the solid polyurethanes is certain to continue, in the hopes that expansion here may rival that in the field of foam rubber.

Chemical intermediates for the polyurethanes are petrochemicals, by and large, so these rubbers are of considerable interest to the manufacturers of petrochemicals.

Silicone Rubbers. Introduced some 12-14 years ago, the silicone rubbers have become accepted as useful engineering materials in applications requiring both high- and low-temperature service (—130 to 500°F); because of resistance to weathering, corona, and ozone; and because of general inertness. Much work has gone into compounding variations, fillers, curing, etc. Basic ingredients of the crude chlorosilane intermediates, by one process, are metallic silicon and methyl chloride (a petrochemical); other organic chlorides (including aryl chlorides such as chlorobenzene, also a petrochemical) are also used. A recent development is a vinyl-containing silicone rubber, said to have advantages in curing, high-pressure-steam service, better oil resistance, etc.

The silicone rubbers are truly specialty rubbers—for use, usually, where conventional rubbers cannot be employed [stationary seals for high-temperature oil lines, high-temperature caulking and sealing compounds, special-purpose gaskets and electrical insulating tapes (often glass-cloth reinforced), conveyor belts for foods, etc.] Prices are still high—$8 lb initially; $3 in 1955; $1 eventually.

Interestingly enough, however, U. S. Rubber and Dow Corning revealed in 1955 that they were experimenting with a tire made of silicone rubber and glass fiber, capable of withstanding temperatures of more than 500°F. Use on automotive vehicles is unlikely, because of the high cost of materials; "however, tires of this nature may be especially siutable for high-speed supersonic aircraft, where the tire may be exposed to temperatures of 400-500°F."

Polysulfide Elastomers. Thiokol, the first polysulfide rubber, went into commercial production in 1930, and various Thiokols have continued in industrial use since that date, largely because of outstanding oil and solvent resistance. These rubbers are the reaction products of organic dihalides such as ethylene dichloride (a petrochemical) and alkali polysulfides. Their other properties include good aging characteristics and exceptional resistance to ozone, but most of them have a disagreeable odor, relatively poor heat resistance, low tensile strength, and poor abrasion resistance in tire threads.

Uses include gasoline hose, printers' rolls and newspaper blankets, liners for bulletproof airplane tanks, gaskets, etc.—applications where resistance to oils, solvents, and water is at a premium.

Acrylic Elastomers. These elastomers, derived from such petrochemicals as ethylene chlorohydrin or acetylene, have the ability to withstand sustained high temperatures (up to 400°F). They are superior in this respect to all commercial elastomers except the silicones, and are less expensive than the latter materials, although by no means cheap ($1.35/lb in 1953). They are inert to oils at temperatures of 300°F and above, and have other properties amenable to specialty uses. Manufacturers include the B. F. Goodrich Co. (Hycar PA, etc.).

Other Rubbers. Several other elas-

Table 4—Producers of and Announced Capacities for Petroleum-Based Butadiene

Company	Location	Announced Capacity (Short Tons) Initial	Expanded
Copolymer Rubber & Chemical Corp.	Baton Rouge, La.	23,000	35,000
Firestone Tire & Rubber Co.	Orange, Texas	—	40,000
Humble Oil & Refining Co.[1]	Baytown, Texas	46,000	65,000
Neches Butane Products Co.[2]	Port Neches, Texas	190,000	300,000
Odessa Butadiene Co.[3]	Odessa, Texas	—	50,000
Petroleum Chemicals, Inc.[4]	Lake Charles, La.	63,000	79,000
Petro-Tex Corp.[5]	Houston, Texas	90,000	170,000
Phillips Chemical Co.	Borger, Texas	74,000	112,000
Shell Chemical Corp.	Torrance, Calif.		
Standard Oil Co. of Calif.	El Segundo, Calif.	63,000	82,000
Texas Butadiene & Chemical Corp.	Houston, Texas	—	43,000
		549,000[6]	976,000[7]

[1]Owned 87.36% by Standard Oil Co. (N. J.)
[2]Owned 50-50 by Goodrich-Gulf Chemicals, Inc., and Texas-U. S. Chemical Co.; these companies, in turn, are 50% owned by Gulf Corp. and The Texas Co., respectively.
[3]Owned 55% by El Paso Natural Gas Co.
[4]Owned 50-50 by Cities Service Co. and Continental Oil Co.
[5]Owned 50% by Tennessee Gas Transmission Co.
[6]Not including about 50,000 short tons/year of capacity privately built before 1955 (Esso Standard Oil Co. at Baton Rouge, La.; Dow Chemical Co. at Midland, Mich.; Union Carbide & Carbon Corp. at South Charleston, W. Va.; Seadrift, Tex. Texas City, Tex.).
[7]Plus capacity reported in Footnote 6, now rated at 55,000 short tons/year. In addition, Esso Standard Oil Co. is reportedly increasing its 6,000 ton/year butadiene capacity at Baton Rouge La.

tomers or elastomer-like materials are in commercial or near-commercial use. On the borderline between plastics and rubbers are certain vinyl resins, based on petrochemical ethylene or acetylene; as mentioned earlier, the U. S. Tariff Commission included the production of 127,821,000 pounds of polyvinyl alcohol, butyral, and chloride in its report on 1955 elastomer output. Polyisobutylenes are finding rubber industry use, as are fluorocarbon elastomers. DuPont announced plans, in late 1955, to build a commercial plant in Beaumont, Texas, to produce chlorosulfonated polyethylene, a petrochemical elastomer especially suitable for white sidewall tires, chemical tank linings, etc., because of excellent color stability and heat and chemical resistance. What with all the present research in the field of polymer chemistry, other elastomers of commercial (at least specialty) significance are certain to be found.

RAW MATERIALS AND INTERMEDIATES

As is common knowledge, petroleum is the major source of materials for the general-purpose S-type elastomers and most of the specialty rubbers. The bulk chemicals (except perhaps styrene) are largely produced by petroleum refiners or affiliates; many of the petrochemicals used in the specialty rubbers, however, are produced by chemical companies.

Butadiene is a basic raw material for the S-type and N-type elastomers. At the end of 1955, total butadiene capacity was rated at 828,000 short tons (661,000 tons petroleum-based, 167,000 tons alcohol-based). By source of material, this grand total broke down as follows: refinery butylenes, 59.2%; butane, 10.6%; alcohol, 20.2%; and ethylene and naptha-cracking processes, 10.0%.

As is shown in Table 4, a vast expansion of butadiene capacity is currently under way, designed to provide for the expansion in S-type rubber capacity predicted in Table 3. The petroleum-based capacity forecasted in Table 4—over a million short ton/yr—is largely scheduled for completion in 1957, and is probably "only the beginning."

Expansion plans continue to be announced at such a rate that two recent Government forecasts for the end of 1957—both released this year—showed totals of only 773,000 and 940,300 short tons, respectively. None of these figures include the alcohol-based butadiene capacity (part in standby; part in operation); all of the expansion, however, is based on butane and butylenes (mostly on butane, via catalytic dehydrogenation).

In regard to alcohol-based butadiene, incidentally, present costs are said to be 15-17.5¢/lb, compared with 14¢ for petroleum-based butadiene. The papers were filled, recently, with accounts of the Government's proposed sale of its Louisville, Ky., alcohol-butadiene plant (capacity: 90,000 short tons per year) to Union Carbide & Carbon Corp., presumably for eventual conversion to the manufacture of other chemicals. This sale was rejected by Congress, and Publicker Industries, Inc., will continue to operate the plant under its lease, which expires in 1958. Future attempts to sell the plant seem likely.

It should be noted that some butadiene is being channeled to growing nonrubber uses—nylon, latex paints, and resins—perhaps 40,000-45,000 short ton/yr, at present. The future for these and other uses now under study looks bright.

Styrene, the "other" raw material for the S-type synthetic rubbers, has previously been chiefly a product of the chemical industry, although it too is a petrochemical—produced from benzene (from catalytic reforming) and ethylene (from the cracking of propane, gas oil, etc.). Interestingly enough, however, the only Government-owned plant, at Los Angeles, Calif. (capacity: 31,250 short ton/yr), was purchased last year by Shell Chemical Corp.

Consumption of styrene for manufacture of S-type synthetic rubbers was approximately 200,000 short tons in 1955, compared with 270,000-300,000 short tons of styrene that went into plastics and coatings; total consumption (which crowded capacity) was about 500,000 short tons. Again, this is "only the beginning"; forecasts of annual capacity are 750,000 short tons by 1961 and perhaps 1.3 million short tons by 1975.

News accounts abound of plans for styrene-plant construction. Firestone Tire & Rubber Co. is planning a 75,000 ton/yr plant for Orange, Texas. Cosden Petroleum Corp. is constructing a 10,000-ton unit at Big Springs, Texas. Foster-Grant is doubling its capacity (to 25,000 ton/yr) at Baton Rouge, La., where U. S. Rubber is also constructing a $1.4-million unit. Bakelite is building a $2.7-million plant at Marietta, Ohio.

More plant expansions seem certain. In this connection, it is interesting to note a recent price cut (to 16¢/lb, in June) plus rumors of contract negotiations for 50,000 ton/yr at 12¢/lb. These are reportedly intended to discourage other rubber companies from going into styrene production for themselves.

Acrylonitrile. This N-type-rubber intermediate is produced from ethylene or acetylene (both petroleum intermediates), depending upon the

manufacturer. Until recent years, most of acrylonitrile production went into the N-type rubbers; now, however, ever-growing quantities are used in the manufacture of the "acrylic" synthetic fibers (perhaps 35,000 short tons in 1955).

Producers include American Cyanamid (Avondale, La.), Monsanto (Texas City, Texas), Carbide & Carbon (Institute, W. Va.), and Goodrich Chemical Co. (Cavert City, Ky.). American Cyanamid has recently announced plans to double the capacity of its Louisiana plant (to 50,000 short ton/yr). Last year, tankcar prices of acrylonitrile were about 27¢/lb.

Isoprene at present, is recovered (extractively distilled) from the C_5 fraction produced by the thermal cracking of gas oils and naphthas, conducted also for the joint production of butadiene (recovered from the C_4 fraction). Tubular furnaces using steam as a diluent in the cracking zone are said to be employed by the only company currently producing this material—Esso Standard Oil Co., at Baton Rouge, La. Esso is reportedly increasing the capacity of this plant, at least for butadiene.

As mentioned earlier, price estimates for the polyisoprene rubbers are based on isoprene at 20-30¢/lb, although a Goodrich-Gulf man is said to believe that 18¢/lb is not out of the realm of possibility. Because it is too soon to determine prospects for the new polyisoprene rubbers on any quantitative basis, forecasts for future isoprene demand are meaningless at present. Perhaps 3,000-4,000 ton/yr are currently used (along with isobutylene) in the manufacture of the Butyl rubbers.

Other Petrochemicals. Space does not permit detailed discussion here of the countless other petrochemicals that go into the manufacture of the specialty rubbers. Much of this information can be gleaned from the petrochemical glossary in this issue beginning on p. 133. Certain of the specialty rubbers, such as the polyurethanes, seem likely to require increasingly large quantities of petrochemical intermediates—glycols, acids, and more complex chemicals—in their manufacture, and this, in turn, may encourage more petroleum companies, petroleum-chemical combines, and petroleum-rubber combines to begin or to expand their operations in this field.

NATURAL RUBBER

No one, even 15 years ago, would have dared to predict that natural rubber in 1956 would be considered only one of several competing elastomers. Admittedly, this is true at present only in the United States, but even abroad plans for several synthetic-rubber plants have recently been announced.

It is now history that the synthetic rubbers became a large-scale commercial reality chiefly because of the emergencies of World War II, when this country was cut off from its major sources of natural rubber. Natural came back into domestic use very quickly, following the war (as shown in Table 1), but supply has often lagged behind burgeoning world demand, causing high and fluctuating prices, and would in any case have been grossly inadequate to meet domestic demand had not the synthetic rubbers been available.

Southeast Asia is the present source of 94% of natural-rubber production—Malaya, Indonesia, Thailand, Ceylon, Vietnam and Cambodia, Sarawak and British North Borneo, India, and Burma. Production in west Africa—mainly Liberia, Nigeria, and Belgian Congo—has been increasing, and now accounts for nearly 5% of world output.

In Southeast Asia, estates over 100 acres in size now account for about half of production; the remainder comes from small holders, whose rubber trees are mostly low yielding, and whose production is thus more costly. Over 400,000 of the 2,040,000 acres on estates were replanted or newly planted with high-yielding stock from 1946 through 1954, and today are coming into rubber production. Malaya and other countries are now engaged in similar programs.

In the near future, during the 1956-60 period, obsolescence of small holdings will probably counteract the effects of these planting-replanting programs, so that no substantial increase in rubber production over 1955 is expected. Unless planting-replanting is continued at a faster rate, annual production by 1975 may not attain the annual rate of 2.5-3.7 million ton/yr predicted by the Paley Commission in 1952.

Increasing quantities of natural rubber are being consumed in foreign countries—1.169 million long tons in 1954 (64.8% of world production), compared with 547,000 long tons in 1947. Foreign consumption by 1960 may well exceed 1.8 million long tons; by 1975, over 2.5 million long tons will be conservatively required. Table 5 is of interest in this respect. Costs for efficient plantations are said to be 12-15¢/lb—lower than the costs for the S-type synthetic rubbers. Competition with synthetic rubber could theoretically become keen in some post-1965 year if total world supply of elastomers should greatly exceed demand; a compensating factor, however, would then be lowered production from high-cost plantations.

RECLAIMED RUBBER AND RUBBER-PROCESSING

No study of the rubber industry can neglect the role of reclaimed rubber. As shown in Table 1, 1955 consumption was 312,800 long tons. This material is "the product resulting from restoring or utilizing waste vulcanized rubbers"—chiefly scrap tires, and usually mixed S-type and natural rubber. Reclaimed rubber is employed because it actually has certain advantages. It is low and stable in price. Its use speeds up milling (because its pigments are already dispersed, and it has been plasticized as well), and permits faster extrusion and calendering. It has excellent aging properties, is subject to rigid quality control, etc.

Use of reclaimed rubber will prob-

Table 5—Potential World Rubber Position, 1956-60

(Thousands of long tons)

Year	World Production, Natural Rubber	United States Consumption: Synthetic and Natural	United States Consumption: 40 Per Cent Natural	Natural for Foreign Consumption	New* Rubber Foreign Consumption	Potential* Foreign Use of Synthetics
1956	1,830	1,458	583	1,247	1,424	177
1957	1,840	1,509	604	1,236	1,510	274
1958	1,850	1,562	625	1,225	1,600	375
1959	1,860	1,616	646	1,214	1,696	482
1960	1,870	1,673	669	1,201	1,798	597

Source: see Reference (2)

*Excluding consumption of synthetic rubber in Iron-Curtain countries.

Table 6—Distribution of Estimated United States New-Rubber Requirements between Natural and Synthetic

(Thousands of long tons)

	1956	1957	1958	1959	1960
Total new rubber	1,458	1,509	1,562	1,616	1,673
Natural at 40%	583	604	625	646	669
Natural at 35%	510	528	547	566	586
Synthetic at 60%	875	905	937	970	1,004
Synthetic at 65%	948	981	1,015	1,050	1,087

Source: see Reference (2).

ably continue to grow—perhaps more slowly than rubber consumption in general, but certainly along with it.

Incidentally, the rubber industry is a vast user of nonrubber chemicals—carbon blacks, accelerators, antioxidants, peptizers, tackifiers, inhibitors, blowing agents, dyes, etc. Many of these are petrochemicals in every sense of the word.

WHAT LIES AHEAD

It is clear, by now, that the field of the various elastomers—natural and synthetic—is a dynamic one, with growth a certainty. Because of growing total demands, real, bitter competition between the synthetic rubbers and natural rubber is at least some years off, although the planned domestic capacity for synthetic-rubber production may well exceed *total* domestic demand of elastomers well before 1960. This latter point is evident from Tables 1 and 6, which show that total domestic new-rubber requirements of 1.673 million tons by 1960 could readily be supplied in their entirety by the domestic synthetic-rubber industry, whose end-1957 capacity alone is expected to be 1,720 million tons.

It is important to note from Table 5, also, that foreign demands for synthetic rubbers will continue to grow, because "it is now too late for the new planting of rubber trees to affect natural-rubber production very much in the early 1960's." Foreign countries may very well face a net shortage of rubber supplies in the 1958-65 period. That this is realized abroad is attested to by news announcements of plans for foreign synthetic-rubber plants. For example, one to produce 40,000-50,000 ton/yr of S-type rubber at Southhampton, England, by International Synthetic Rubber Co. (a firm including Firestone and Goodyear); and one to produce 15,000 tons of S-type rubber on Trombay Island in India (shades of "India rubber"!), using "waste products of the Stanvac and Burmah Shell refineries."

Also planned are a 20,000-metric-ton Butyl-rubber plant in France, at Port Jerome in the LeHavre region; a plant to produce 30,000 tons of S-type rubber in West Germany by Chemishe Werke Huels (using alcohol butadiene); and two Japanese projects—a 15,000 ton S-type rubber plant by Mitsubishi Petrochemical, and Furakawa-combine plants to produce 15,000 tons of S-type, 1,500 tons of Butyl rubber, 600 tons of N-type, and 5,000 tons of polyisoprene rubber.

This review has not attempted to touch upon every phase of the synthetic rubber industry—a book would be required for that (and a good one was published in 1954). Developments in the production of synthetic latices have gone relatively unnoted, except for the S-type rubbers; however, excellent ones are in production for many of the other elastomers, and total consumption is expected to increase rapidly.

Little attention has also been given to the "why" of expanding rubber demands—growing use for conventional products such as tires and mechanical goods, and new uses such as air springs for vehicles, automobile fuel lines, crash pads for auto-instrument panels, passenger conveyor belts, rubber-containing asphalts for highways and all-weather playground surfaces, etc.

In the realization of this glowing future, the petroleum industry will play a leading role. Petroleum companies are already firmly established as major suppliers of petrochemical intermediates, and as producers of synthetic rubbers (by themselves, and through combines with rubber companies). They are stepping up to their responsibilities (and opportunities) by constructing new plants, and by expanding existing ones. As announcements of entirely new petrochemical elastomers indicate, there is no certainty that the S-type rubbers will continue to dominate the synthetic-rubber industry indefinitely, but if or when they are replaced—certainly not in the immediate future—it is almost certain that they will be supplanted by other petrochemical rubbers, such as the polyisoprenes and polybutadienes.

Meanwhile, the nation can rest assured that its synthetic-rubber production capacity (present and planned), plus its national strategic stockpile of natural rubber, are adequate to take care of any emergency. In peacetime and, if need be, war, synthetic rubber is here to stay.

Meet The Author

Mr. Weil

B. H. Weil graduated in 1939 from the U. of Missouri with a B.S. in Ch. E. and received an M.S. from the U. of Wisconsin in 1940. He has specialized since his school years in industrial management research services, serving as head of the Information Section of the Chemistry Division of Gulf Research and Development Co., as head of the Technical Information Service of the State Engineering Experiment Station of the Georgia Institute of Technology, and is now manager of Information Services of Ethyl Corporation Research Laboratories, in Detroit, a position he has held since 1950.

Mr. Weil has written four books, several book length literature surveys, over 100 articles and papers, and is currently contributing editor of the "Do You Know These Words Section" of PETROLEUM PROCESSING.

Mr. Weil is married, has two children, and is a member of the ACS (where he is editor of *Chemical Literature*), the SAE, the American Documentation Institute, and the Special Libraries Association.

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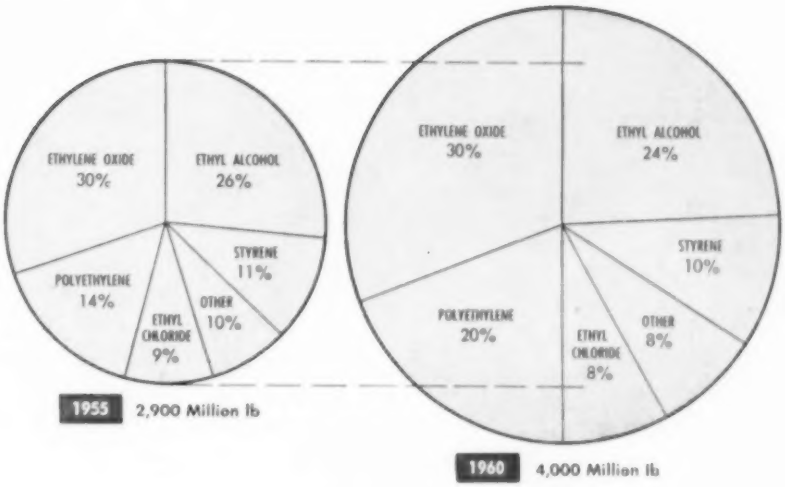

Fig. 1—**SHIFTS IN END USE** pattern for ethylene show that biggest change by 1960 will probably be in polyethylene growth, a significant factor in . . .

Versatile Ethylene

Its spectacular growth continues skyward

By W. E. KUHN and J. W. HUTCHESON
The Texas Co., Beacon, N. Y.

ETHYLENE, one of the most versatile of chemical raw materials, shows no signs of a growth slowdown. In 1951 consumption was 1,700,000,000 lb. Our survey of ethylene chemicals at that time* placed the 1962 demand conservatively at a tremendous 3,900,000,000 lb. This current review indicates the 1951 forecast was conservative and that a consumption of 4,000,000,000 lb of ethylene will be reached by 1960.

The end-use pattern for ethylene in 1955, illustrated in Fig. 1, differs from that of most years. Only in a few of the years prior to 1955 has the production of ethylene oxide required more ethylene than ethyl alcohol. Between now and 1960, ethylene oxide will continue as the major consumer of ethylene.

The rapid rise in polyethylene is another spectacular change. In 1954 demands for ethylene for this commodity exceeded all uses except ethylene oxide and ethyl alcohol. Polyethylene has become firmly established in third place as a ethylene consumer.

Briefly, we'll review the major chemical derivatives of ethylene to provide a composite picture of total ethylene demands for the period of 1956 through 1960.

Ethylene Oxide

In the past, ethylene oxide production has been geared primarily to the demands for ethylene glycol. Although ethylene glycol will continue to dominate ethylene oxide production, other outlets are providing substantial markets. The polyglycols, glycol ethers, acrylonitrile, ethanolamines and nonionic surface-active agents are among the growing uses of ethylene oxide. Increased ethylene oxide requirements for acrylonitrile will be moderated by the use of acetylene for acrylonitrile manufacture.

Fig. 2 shows the growth in oxide production and the amount going into ethylene glycol. Demands for ethylene oxide are placed at 1,100,000,000 lb in 1960. About 1,200,000,000 lb of ethylene will be required to meet this demand.

Present producing capacity is nearly evenly divided between two processes—chlorohydrination and direct oxidation. In the next five years new facilities will be based predominantly on direct oxidation. Some existing chlorohydrin facilities may be replaced by direct oxidation equipment.

Ethyl Alcohol

The total annual production of ethyl alcohol from all sources has fluctuated widely over the past 15 years. The production of ethyl alcohol from ethylene, however, has shown a steady yearly increase. Demands for ethyl alcohol for chemical and solvent use continues at a brisk pace. Fig. 3 shows the total production of ethyl alcohol and the amounts derived from ethylene. Total demands are placed at 302,000,000 gal in 1960. Of this total 222,000,000 gal is expected to be derived from ethylene. The remaining 80,000,000 will be obtained by fermentation. Ethylene requirements for ethyl alcohol in 1960 are placed at 977,000,000 lb.

It must be remembered that both economics and politics have to be considered in calculating the distribution of ethyl alcohol raw materials. The forecast presented does not allow for any drastic change in the government regulations on the use of carbohydrate raw materials.

Polyethylene

The spectacular rise of polyethylene is a result of three important factors working together. A readily available raw material was converted by a well-defined process into a product of

*"Ethylene Petrochemicals—Today and Tomorrow," by W. E. Kuhn and J. W. Hutcheson, PETROLEUM PROCESSING, Oct. 1951, and Nov. 1951.

multiple uses in a given field. Polyethylene has become firmly established in the plastics industry. Fig. 4 illustrates the growth in polyethylene production. By 1960 demands for polyethylene are expected to reach 800,000,000 lb. Ethylene requirements by 1960 should reach the same figure.

These demands include both high- and low-pressure polyethylene. Prospects for low-pressure polyethylene look very promising. The growth in use of the low-pressure product combined with the competition expected from polypropylene may result in an excess of high-pressure polyethylene facilities by 1960.

Styrene

The production of styrene jumped to over a billion pounds in 1955, with synthetic rubber (GR-S type) and styrene plastics contributing predominantly to the demands. These end uses are expected to provide the major outlets for increasing styrene demands.

Fig. 5 presents the production of styrene since 1940 and the forecast to 1960. The future demands have been tempered slightly by the prospects of improved styrene plastics and synthetic rubber based on methylstyrene. It also is possible that styrene plastics may not be able to hold all of the market percentage in 1960 that they now enjoy. Even so, 1960 demands for styrene are expected to reach 1,300,000,000 lb. This quantity of styrene will require 416,000,000 lb of ethylene.

Ethyl Chloride

Demands for ethyl chloride have continued to increase annually since 1947. The manufacture of tetraethyl lead for anti-knock fluids is the largest outlet for ethyl chloride. TEL production has grown strongly in the past ten years. Fig. 6 shows the growth in ethyl chloride production and the amount derived directly from ethylene. Some 65,000,000 lb of ethyl chloride was derived from ethyl alcohol in 1955. Future demands will be tied closely to TEL demands.

In 1960 ethyl chloride requirements are placed at 700,000,000 lb and all but 65,000,000 lb will come from ethylene by hydrochlorination. Ethylene requirements for direct conversion to ethyl chloride in 1960 will be 309,000,000 lb.

Other Uses

There are a number of other important ethylene chemicals which, for this review, have not been considered individually. Such products include ethylene dichloride, ethylene dibromide and other halogenated ethylene derivatives. Growth prospects for these materials are in keeping with most of the products already discussed. To meet these increased demands, ethylene requirements will increase from an estimated 288,000,000 lb in 1955 to 360,000,000 lb in 1960.

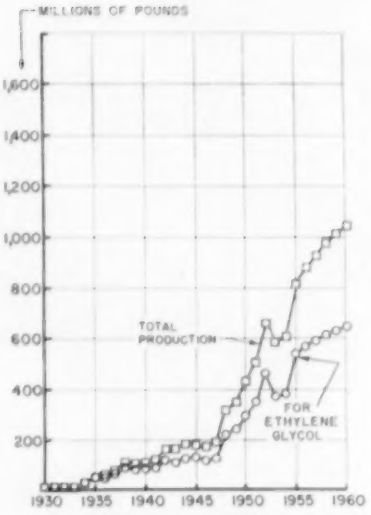

Fig. 2—**ETHYLENE OXIDE**, total production and amount used to make ethylene glycol

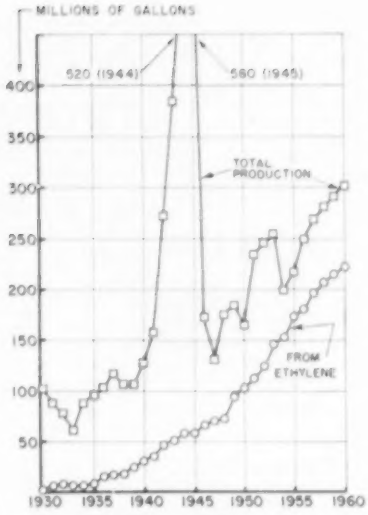

Fig. 3—**ETHYL ALCOHOL** (95% by volume), total production and amount from ethylene

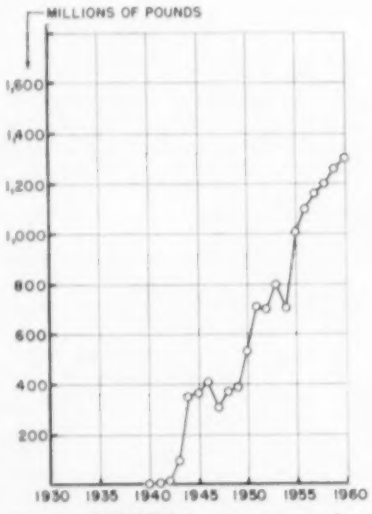

Fig. 5—**GROWTH** in styrene production from 1940 to 1960

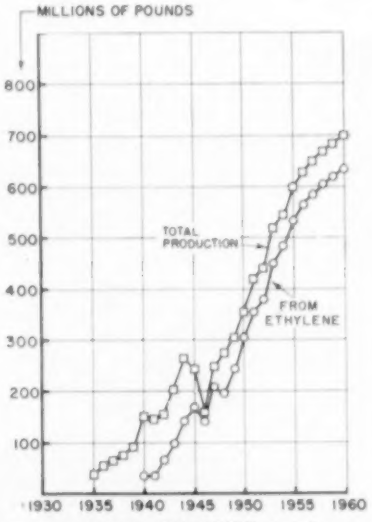

Fig. 6—**ETHYL CHLORIDE**, total production and amount from ethylene

Total Demands

In 1950 ethylene demands were 1,400,000,000 lb. Demands increased 1,500,000,000 lb and reached 2,900,000,000 in 1955. The growth anticipated for the period between 1955 and 1960 does not quite reflect the rapid growth of the past 5 years, but only minor slackening is anticipated. It is estimated that demands for ethyl-

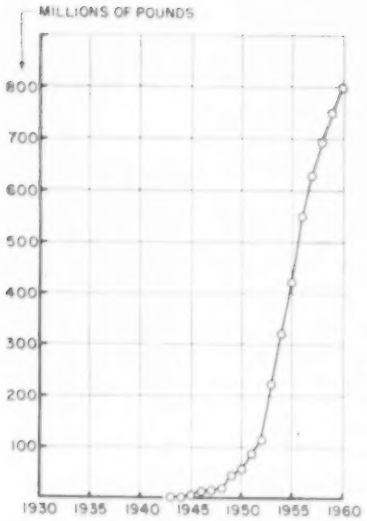

Fig. 4—**GROWTH** in polyethylene production projected to 1960

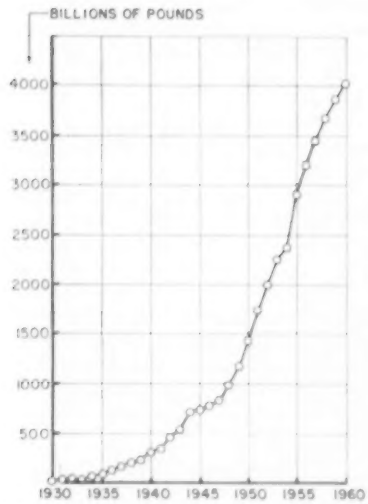

Fig. 7—**TOTAL** ethylene consumption

ene in 1960 will reach 4,000,000,000 lb. The growth of ethylene consumption for the period 1930 to 1960 is shown graphically in Fig. 7. The annual ethylene demands for the same period, broken down into major end uses are given in the accompanying table.

It is readily apparent that ethylene chemicals have not yet reached maturity.

Annual Consumption of Ethylene—Projected to 1960

(Millions of Pounds)

	Ethylene Oxide	Ethyl Alcohol[1]	Polyethylene[2]	Styrene[3]	Ethyl Chloride[4]	Other	Total
1930	14	4				3	21
1931	11	30				4	45
1932	8	33				4	45
1933	9	26				6	41
1934	31	28				6	65
1935	47	41				6	94
1936	58	73				10	141
1937	75	78				15	168
1938	102	82				19	203
1939	102	122				25	239
1940	105	142		1	18	36	302
1941	123	162		1	18	45	350
1942	160	210		3	33	55	461
1943	166	224	1	31	48	76	546
1944	182	264	3	112	69	89	719
1945	177	259	6	116	82	91	731
1946	175	295	13	130	70	97	780
1947	195	309	16	99	103	117	839
1948	309	325	19	121	96	121	991
1949	349	418	42	125	119	130	1,183
1950	433	458	55	173	148	160	1,427
1951	521	499	85	226	172	228	1,731
1952	680	554	115	224	185	235	1,993
1953	613	649	225	255	219	292	2,253
1954	646	676	320	225	236	262	2,365
1955	864	760	420	324	260	288	2,916
1956	937	793	550	352	275	300	3,207
1957	1,005	862	630	371	285	305	3,458
1958	1,065	911	695	384	295	329	3,679
1959	1,121	946	750	403	302	342	3,864
1960	1,176	977	800	416	309	360	4,038

(1) Assuming 4.4 lb of ethylene makes 1.0 gal of 95% ethyl alcohol.
(2) Assuming 1.0 lb of ethylene makes 1.0 lb of polyethylene.
(3) Assuming 0.32 lb of ethylene makes 1.0 lb of styrene.
(4) Assuming 0.487 lb of ethylene makes 1.0 lb of ethyl chloride.

Meet the Authors

W. E. Kuhn

J. W. Hutcheson

Dr. Wayne E. Kuhn, general manager, Research and Technical Department, The Texas Co., hails from Oshkosh, Wis., where he was born in 1903. Educated in Portland, Ore., he received a Reed College B. A. in 1925. He then attended Cornell University, receiving a Ph.D. degree. He joined The Texas Co. as a chemist at Bayonne, N.J., in 1929. After Bayonne and, later, Port Arthur, Dr. Kuhn was transferred to New York as assistant chief chemist. He then was made assistant director of research, assistant manager of the Technical and Research Div., and manager of that division in 1938. In 1954 he received his present position.

In 1950, Dr. Kuhn was awarded the Honor Scroll of the New York Chapter of the American Institute of Chemists; in 1953 he was awarded a Certificate of Appreciation from the American Petroleum Institute.

John W. Hutcheson is a research chemist in the Beacon, N.Y., laboratories of The Texas Co. A native of Missouri, he received his B.A. from Central College, Fayette, Mo., and his M.A. from Oklahoma A&M, Stillwater, Okla., in 1941. Shortly thereafter, he joined The Texas Co. research staff at Beacon, N.Y.

Other Major Petrochemicals

Supply: Going Up
Demand: Going Up

AUTHORITIES on each of the major petrochemicals have given PETROLEUM PROCESSING *the supply-demand picture in their specialties for 1956 and beyond.*

Here are the conclusions. The individual reports start in the next column . . .

AROMATICS: Growing output from catalytic reforming units is outstripping growing demand. Current needs for petroleum benzene will increase because of the drop in coke-oven benzene caused by the recent steel strike.

BUTADIENE: U. S. capacity will have to be expanded to about 1,115,000 t/yr by 1959 to supply GR-S rubber and other petrochemical needs. (See also special depth report on Synthetic Rubber, this issue, pp. 98-106).

FORMALDEHYDE: Rapidly approaching supply-demand balance. But steady growth of demand over the next 20 years assures healthy future. Growth rate of about 100 million pounds per year will accelerate.

CARBON BLACK: One of the two dark spots. Shipments in '56 and '57 will not reach the 1955 peak level. Production is greater than demand, and carbon black stocks are starting to rise.

SYNTHETIC DETERGENTS: Though 1956 sales are increasing, and should reach 2.8 billion pounds, the oft predicted leveling off point of 75% synthetics, 25% soaps is near.

PLASTICS: Only styrene will not be talking part in the almost 100% sales increase predicted for plastics by 1960. The big influence on plastics' future is expected to be the growing use of vinyls. (See also special depth report on Ethylene, this issue, pp. 107-109).

SULFUR: Mexican Frasch sulfur is providing serious competition for the growing production of sulfur recovered from natural and refinery gases.

NITROGEN PRODUCTS: The other dark spot. Increasing capacity, combined with this year's agricultural letdown is adding urgency to the development of natural geographic markets for ammonia.

Aromatics

Cat Reformers Boost Supply

Meet the Author

Mr. Bramston-Cook

Harold Edward Bramston-Cook was born in England in 1899. He studied in England and Canada, receiving his M.A. Sc. in Chemical Engineering from the University of British Columbia in 1925. He was with Union Oil Co. of California from 1927 to 1946. He then became sales manager for Oronite Chemical Co., San Francisco. He is now vice president in headquarters in N. Y.

INTEREST in aromatic chemicals is growing. The reasons: Their increased production, and the rise of the catalytic reformer. The superior quality of aromatic derivatives is being recognized in many applications in plastics, synthetic fibers, paints and other surface coatings, pharmaceuticals, dyes, and so on.

Until World War II, the principal aromatic chemicals, benzene, toluene and xylene, were recovered almost entirely as a by-product of coke oven operations. Today, however, the petroleum industry is supplying the major share of the aromatic hydrocarbons produced in th U. S.; over 50% of the total benzene output, around 75% of the toluene, and over 90% of the xylenes.

Total production of the three basic aromatics from petroleum sources in 1955 was 2,460,359,000 lb, a gain of 7.5% from 1954, as reported by the U. S. Tariff Commission. Total sales last year were 1,716,589,000 lb, a gain of 17.1% from 1954. (See table.) Total value of sales in 1955 was $75,063,000, an increase of nearly 15% from the total 1954 sales value of $66,277,000. The unit sales value for benzene remained 6¢ lb in both years, and for toluene and xylenes, 4¢. The latter value, however, may give the chemical industry a false picture, because the solvent grades of toluene and xylene cost nearly 5¢ lb delivered. Moreover, in large lots, xylene isomers range from about 6¢ lb for orthoxylene to about 25¢ lb for metaxylene.

Production and Sales of the Basic Aromatic Hydrocarbons from Petroleum for Chemical Conversion 1954-1955

(Reported by Chemical Division of U. S. Tariff Commission)
(1000 lb)

	Production		
	1955	1954	% Gain 1954-55
Benzene (except motor grade)	722,650	673,715	7.3
Toluene	1,038,290	889,687	16.7
Xylenes mixed	699,455	726,041	3.7 Loss
Total	2,460,395	2,289,443	7.5

	Sales		
	1955	1954	% Gain 1954-55
Benzene (except motor grade)	521,236	379,049	37.5
Toluene	713,075	677,461	5.3
Xylenes mixed	482,278	409,901	17.7
Total	1,716,589	1,466,411	17.1

Continued growth in 1956 in the production of aromatic petrochemicals is indicated in Tariff Commission data for selected organic chemicals. While sales data are not yet available, if the steel strike continues, reducing the output of coke oven aromatic chemicals, demand for petroleum aromatics will be increased this year. Benzene will be most affected.

For the first four months of 1956 output of benzene from petroleum refineries was 275,922,436 lb, nearly 20% larger than the 229,901,916 lb produced in the same period in 1955. Toluene production, except that from coke ovens, was 332,298,096 lb in the first four months, nearly 14% larger than in 1955. Output of xylenes from both coal tar and petroleum sources was 303,795,698 lb, about 14% larger than the 267,215,302 lb produced in the same period in 1955. Probably the most dramatic developments in the last ten years are the large scale production of commercially pure xylene isomrs, the vast impact of benzol-based synthetic detergents and the cumene process for phenol.

A recent development among the aromatic petrochemicals is vinyl toluene, a monomer in which tolune is the aromatic base material. This product first became available in 1954 and shows promise of becoming a useful addition to the field of plastics materials. It can be used in latex type paints, synthetic rubber and plasting molding compounds among other uses.

The epoxy resins are another new development stemming from aromatic raw materials. Sales of epoxies in 1950 were 2 million lb; today they are around 28 million lb and growing rapidly. Applications include strong and durable furniture and appliance finishes, coating for concrete, can linings, etc. Their excellent bonding properties open another field of usefulness.

Butadiene

Big Demand Means More Capacity

Meet the Author

Mr. Hornaday

George F. Hornaday, Assistant Process Sales Manager, Houdry Process Corp., Philadelphia, is a native of Indiana. He received his B.S. in chemical engineering at Purdue University, and joined Houdry in 1940 as Assistant Manager of Development. Shortly after Pearl Harbor he was assigned to development work on the use of the Houdry dehydrogenation process for the single-step production of butadiene from normal butane for the synthetic rubber program. In 1952 he joined the commercial department of the company.

UNUSUAL interest has focused on the expansion of butadiene production since the sale of the government butadiene plants to private industry in 1955. Most of the purchasers have invested additional money to increase production by eliminating "bottlenecks" in existing equipment.

In addition to this expansion, other companies are building new facilities for the production of butadiene and butenes from normal butane. During the past year, the Houdry Process Corp. has licensed units in the U. S. capable of producing 250,000 t/yr of butadiene from normal butane. At the beginning, several of these plants will produce butenes as well as butadiene. It's estimated that these units will produce 225,000 t/yr of butadiene and 118,000 t!yr of butenes. The butenes will be used for alkylate production or will be charged to existing butene dehydrogenation units. Construction of these plants will be completed by mid 1957.

The reason that all of the announced new plants are using normal butane as a feed stock is the relatively large supply of normal butane, compared with normal butenes, and the lower cost of normal butane. In addition, the purification of the butenes prior to dehydrogenation is more costly because of the high investment cost and larger utility requirements.

If normal butane is available at 5.5¢/gal and normal butenes are available at 17.5¢/gal, the feed cost for a pound of butadiene is less by about 2-2.5¢ per pound of butadiene when using normal butane. Indications are that there will be little change in this price ratio for several years. Butane prices should be fairly stable because of the large supply. Butenes will be in limited supply because of their value in the production of alkylate for use in aviation and motor gasolines, as well as the production of "cat poly" for motor gasoline blending. The trend towards higher octanes will increase the value and decrease the supply of butenes.

If the information presented in "The Rubber Requirements and Resources of the United States" report from the Office of Defense Mobilization is used as a basis for a forecast and is corrected for increased butadiene expansion that has been announced, it appears that butadiene expansion of at least 233,000 t/yr will be made by 1959 in addition to the expansion that has been announced. This expansion may be even larger if the uses of butadiene in other petrochemicals develops as expected. According to government estimates, the annual capacity of the GR-S plants will reach 1,285,100 t/yr in 1959. This would require an annual capacity of approximately 1,025,000 tons of butadiene.

The government's estimated butadiene capacity in 1957 is 718,000 t/yr and additional plants totaling 143,000 t/yr have been announced recently. The revised estimate is 861,000 t/yr of butadiene capacity by the middle of 1957. Since only 92% of the butadiene production has been used in GR-S rubber, only 792,000 tons of butadiene are available for this purpose, thereby requiring an additional 233,000 tons of butadiene capacity by 1959 to satisfy the estimated requirements of the GR-S plants at that time.

An accurate forecast of butadiene production in the U. S. is made more difficult because of the potential demand for synthetic rubber in foreign countries.

Any decrease in the price of butadiene resulting from the new efficient and more economical butadiene plants using normal butane as a feed stock would tend to lower the manufacturing cost of synthetic rubber and increase its use. Cheaper butadiene will also stimulate the interest of a number of companies in using butadiene as a building block for other products. These factors will materially increase the demand of butadiene.

Formaldehyde

Supply, Demand Grow in Balance

Meet the Author

T. G. Davis graduated (B.S. Chemistry) from the University of Maryland, and joined Celanese in 1933 as Chemist at the Corporation's Cumberland, Md., plant. He was appointed product development manager for the Chemical Division in 1947, and in 1950 was appointed to the Chemical Division's sales staff as district manager for the midwest. Three years later (March, 1953), he was promoted to product manager for intermediates (including formaldehydes) at the firm's Chemical Division administrative headquarters in N. Y.

FORMALDEHYDE today is rapidly approaching a supply-demand balance. Available U. S. capacity, already more than adequate for present demand, will be approximately 2,500,000,000 lb annually by the end of 1956, but an estimated actual production for the year will only be about 1,400,000,000 lb. This difference in figures could mean a glutted market except that nearly half of the total capacity (2.5 billion pounds) is in the hands of producers who have captive requirements.

Of the seventeen listed producers, all but one utilize methanol as the raw material source. Celanese, with the second largest output in the U. S. (DuPont first), oxidizes selected petroleum hydrocarbons (chiefly propane, butane) with air at low pressures.

The in-plant requirements of at least twelve of the producing companies remove them to a complete or partial degree from external activity on formaldehyde, so that the competitive market narrows down to about half of the total list. Because of the wide geographical distribution of producing sites (from Texas to the Mid-West, West Coast and the East Coast) and to the low selling price of this chemical, the physical distribution of product to consumer has called upon all the skills and facilities offered by technical personnel and modern shipping techniques.

Coastal tankers and river barges compete with railroad tankcars and highway tanktrucks to maintain profitable operations for the producer and deliver specification material to the customer.

The steady growth of formaldehyde demand over the next twenty years seems assured on the basis of projected markets for phenolic, urea and melamine resins, pentaerythritol, glycol and miscellaneous chemical products. The current growth rate of about 100,000,000 lb/yr is not yet in its steepest climb according to the estimates of forecasters such as the President's Materials Policy Commission.

Phenolics and ureas alone account for nearly half of the total formaldehyde consumed annually, and the end-use pattern is growing constantly, particularly in adhesives for the plywood, building and furniture markets. One of the newest developments is "particle board," which is made from resin and wood chips, shavings, etc. In addition to saving many trees, this product is lower priced than wood, yet fills many of the requirements of lumber for structural and decorative purposes in many fields.

The demand for molded plastic products continues to take huge quantities of phenolic, urea and melamine molding compounds.

Pentaerythritol for resins in the surface coatings field, and ethylene glycol account for the two next largest segments of the formaldehyde use picture.

Hexamine, textile treating resins, leather chemicals, embalming compounds and miscellaneous chemical derivatives, including the new urea-formaldehyde fertilizers, account for the rest of the total demand.

As the demand for formaldehyde keeps growing and new supply sources are established, marketing and consuming practices are also changing. The largest volume market is still formalin, the 37% aqueous solution, but the trend is shifting toward higher concentration solutions (44, 45, 50%) to avoid paying freight on water, to economize storage space, and to achieve higher process efficiencies.

Several formaldehyde producers have encouraged new industrial approaches for improved resin manufacturing by offering new or up-graded types of formaldehyde containing materials; e.g., Celanese with large-volume, low-cost paraformaldehyde (the linear polymer), "Formcel" solutions (formaldehyde in selected alcohols), and Trioxane (the anhydrous trimer); Nitrogen Division of Allied Chemical and Dye Corporation with their UF-85 complex (a liquid mixture of formaldehyde, urea and water).

Carbon Black

Demand Is Lagging Supply

Meet the Author

Mr. Beede

Alan F. Beede has been associated with Godfrey L. Cabot, Inc., since 1943. He originally served the company as assistant to the treasurer. In 1950 he organized and became director of the Economics Department. Mr. Beede received his B.B.A. from the University of Washington and his M.B.A. from the Harvard Graduate School of Business Administration.

CARBON BLACK shipments from U. S. plants for both 1956 and 1957 promise to be substantially below the peak level of 1955. Present production and potential production in the form of both unused and

Carbon Black Demand

Figures in Millions of Pounds

	Actual 1955	Estimated 1956	Estimated 1957
U. S. Plant Shipments to Domestic Market	1374	1230	1250
U. S. Plant Shipments to Overseas Markets	454	400	390
Total U. S. Plant Shipments	1828	1630	1640
Non-U. S. Plant Shipments to All markets Estimated	277	340	380
Total Free World Shipments	2105	1970	2020

newly constructed facilities is greater than demand, and stocks are rising.

The pattern of demand shown below is one of relative stability for the Free World, comprising a decline in the domestic market and an increasing consumption in overseas markets through 1957. A larger proportion of shipments overseas will probably be supplied by plants outside the U. S.

Carbon black capacity in the U. S. by the end of 1956 is estimated at 2,277,000,000 lb. Certain proposals for additions to U. S. capacity both by new entries into the industry and by present producers have recently been shelved. Abroad, however, capacities of existing plants have been enlarged in Canada, in the U. S., and in West Germany. New plants are, or will shortly be under construction in France, Australia and Brazil.

The government of India is seriously investigating the establishment of a carbon black plant in that country. Total world carbon black capacity by the end of 1956 is estimated at 2,667,000,000 lb. A year later the potential should approximate 2,830,000,000 lbs and, of the 166 million-pound increase, only slightly more than one-third is scheduled to take place in the U. S.

The effect during 1956 and 1957 of additional foreign capacity will probably be to depress shipments from U. S. plants to overseas markets. Over the longer term, however, exports from U. S. plants will probably rise, surpassing the all-time peak of 1955. The reasons lie in a rapidly growing overseas consumption of rubber and carbon black.

None of the planned new capacity will produce channel blacks. It now seems that the U. S. demand for these blacks may decline even faster in the future than it has in the past because of the growing acceptability of oil furnace grades for truck tire natural rubber formulations. In the past, this has been an end use reserved for channel blacks. The relative decline has been steady and significant as shown by the percentage of channel blacks to total U. S. plant shipment:

1953	1954	1955	1956
29%	28%	25%	23% Est.

Channel black producers have been faced with rising gas costs. As old, long-term contracts with low prices have expired, they have been forced to compete with other users of gas at field prices ranging from 12 to 15¢/mcf. Production of channel black from such high cost gas is uneconomical at present prices.

The Bureau of Mines reports that the *average* value of gas used in the manufacture of carbon black has risen nearly eight-fold from the period 1941-1945; it is estimated that the 1956 average price will be ten times the 1941 price.

Despite the pressure of higher gas costs, channel black prices were included in an adjustment of the carbon black price structure that occured in the spring of this year. On January 1, 1956 and again in May, price reductions were made for oil furnace grades, where the pressure of excess capacity is most pronounced. From an orderly adjustment of both the base prices on large-volume oil grades and the premium charged for packaged shipments, price reduction spread widely to include blacks made from gas, by both the channel and furnace processes. Because of the importance of raw material costs in the manufacture of carbon black, it seems reasonable to expect either a tendency to terminate production of gas blacks or an upward adjustment of price.

The rubber industry continues to be the dominant user of carbon black—the Bureau of Mines reports that approximately 94% of all black is destined for rubber manufacturers and 6% for other markets. There seems little reason to feel that rubber will be displaced from its commanding position. Carbon black markets other than rubber may increase importantly, but not sufficiently to change the well-established pattern of carbon black consumption.

Synthetic Detergents

Sales Are Climbing to Plateau

Meet the Author

Dr. Price

Dr. Donald Price, consulting chemist, New York, studied at Columbia; recived his Ph.D. in synthetic organic chemistry in 1930. He carried on Post-Doctorate Research in England, Germany and Austria, and taught at Columbia. He was Technical Director, Oakite Products, Inc., New York, 1945-54, before becomming a consultant. He is the author of 35 U. S. and foreign patents.

THE FIVE-YEAR-OLD boom in synthetic detergents continues. Sales of finished detergents increased 12% in 1955 to a new high of 2.6 billion lb, while soap sales decreased 7%. The synthetics have now captured 62% of the market and are fast approaching the often-predicted levelling-off point of 75% synthetics—25% soap.

Many factors have contributed to the phenomenal growth of the synthetics, chief of which are: the continued introduction of new products, such as liquid and "controlled suds" detergents, and the aggressive advertising of the major soap companies. Prophecy is risky in such a fast-moving field; but it seems safe to predict that the synthetics will have taken 75% of the soap and detergent market by 1960. Whether or not soap and the synthetics will level off on a 25%-75% basis remains to be seen.

Sources of raw materials for the production of synthetic detergents are fats, coal tar and petroleum, with petroleum taking the lion's share. More than 50% of all the synthetics produced consist of alkyl aryl sulfonates, largely made from benzene with a side chain averaging twelve carbon atoms.

Sales of Finished Synthetic Detergents

(Data from Assn. of American Soap and Glycerine Producers)
(Billion lb)

1950	1.249	1953	2.134
1951	1.434	1954	2.358
1952	1.749	1955	2.649
1956 (Est.)		2.800	

It has been estimated that 22 million gal of benzene were consumed to make dodecyl benzene in 1955 and that this year will see a 5-10% increase in its use for this purpose. Petroleum-derived benzene certainly gets a substantial share of the market. The alkyl side chains of the alkyl aryl sulfonates are either made from straight chain petroleum hydrocarbons or polypropylene, another petroleum derivative.

The non-ionics are the fastest growing detergents. They are made by reacting compounds containing an active hydrogen such as fatty acids, rosin acids, fatty alcohols and alkyl phenols, with ethylene oxide so as to build up a polyoxyethylene chain. One reason for their steady growth is their versatility. By varying the length of the ethylene oxide chain, solubility, detergency, foaming and other properties can be widely varied; besides they can be sulfonated. The petroleum industry shares in the growth of the non-ionics, not only through the alkyl phenols but through the increased use of ethylene oxide.

Accurate estimates of the production of synthetic detergents according to type are extremely difficult to make. The U. S. Tariff Commission publishes figures for the production of surface-active agents on the 100% active basis, but many substances are included which, strictly speaking, cannot be considered synthetic detergents. Nor is there a breakdown into the major classes, anionics, cationics and non-ionics.

A study of government figures, as well as of those from other sources, seem to justify the breakdown of current production approximately as follows: alkyl aryl sulfonates 50%; alcohol sulfates 15%; non-ionics 25%; cationics 1.5%; all others 8.5%. During the last few years the production of alkyl aryl sulfonates has shown a moderate but steady growth, that of the alcohol sulfates has been quite small, whereas the non-ionics have gone ahead by leaps and bounds.

By far the largest share of synthetic detergents (about 80%) goes into household consumer products, divided into granular package products and liquids used largely for dishwashing. It was recently estimated that the liquid detergents would reach 150 million lb in 1955 or about 7% of the household market. The remaining 20% of synthetic detergents go to industrial users in several dozen industries, with textiles leading the parade.

The industrial markets have shown a steady growth for well over twenty-five years, but they are now eclipsed by the vast consumer market that has grown up entirely since World War II.

New developments in household detergents are synthetic bars and all-purpose liquid detergents. Several synthetic bars have been test-marketed but so far they have not given soap bars really serious competition. The problem is a difficult one; the synthetics do not lend themselves well to the solid bar form. The chances are that cake soap will be around for a long time to come. It is a different story with the all-purpose liquid detergents. There are several being sold in limited markets and they seem to be doing well.

The all-purpose liquids compete directly with the heavy-duty, all-purpose package products, so that the detergent producers will be competing against themselves. Liquid detergents have certain advantages, however, the most important of which is that they can be readily metered. It is rumored that at least one manufacturer of washing machines plans to put metering devices on his new models.

The impending battle between all-purpose liquid and all-purpose solid household cleaners is unlikely to affect the petroleum industry's share of the market for detergent raw materials, because the same or even greater.

Plastics

Sales Should Double by 1960

Meet the Authority

Mr. Brown

After the first world war, Gordon Brown joined the Condensite Company of America, which was merged in 1922 with the Redanol Products Company and the General Bakelite Company to make the Bakelite Corporation.

Mr. Brown has been with Bakelite ever since. His present position is vice-president in charge of market research of Bakelite Company, a division of Union Carbide and Carbon Corp.

In 1937 Mr. Brown founded the Society of the Plastics Industry and served as its president in 1951 and 1952.

PREDICTIONS that the use of petrochemicals in plastics will double by 1960 are borne out by the growth data on seven principal types of petrochemicals supplied PETROLEUM PROCESSING by Gordon Brown, vice president of Bakelite Co., New York. The list includes the fast growing and large volume vinyl resins and polyethylene.

The data compares sales of the plastic materials in 1955, 1956 and 1961. The volume of sales is expected to increase almost a third from 1955-57, and over 98% from 1955 to 1960. A moderate decline in sales is anticipated in styrene only, because of the advent of the new type polyethylene compounds. Detailed data is given in an accompanying table.

"The outstanding developments under way at present that will affect the plastic future are the increasing use of vinyls resulting from reduced selling prices and from improved compounds of many types," stated Mr. Brown. "Principal among the compounds having a most opportunistic future are vinyl acetate emulsions for use in protective coatings.

"The future of polyethylene is expanding both because of the great versatility of the material in its present forms and because the 'high density' type, which is stronger and more rigid, will further increase the possibilities of use. It is the advent of the latter type of material, which in our estimate, will affect adversely the future of styrene compounds. Such is the ingenuity of

Estimated Growth Rates for Seven Principal Plastic Materials

(Million lb)

	1955	1957	1961	% Gain 1955-61
Vinyl Resins	1,068	1,538	2,721	155
Polyethylene	297	725	1,379	364
Polystyrene	1,042	1,039	960	8 Loss
Phenolics	446	487	582	31
Polyesters	52	64	96	85
Fluorocarbons	1.6	2.1	6.4	300
Epoxies	18	29	59	228
Total	2,924.6	3,884.1	5,803.4	98

chemists, however, that we may find ourselves in another year or two re-estimating styrene to have a more optimistic future than we presently anticipate.

"The polyesters are enjoying a considerable expansion in a great variety of applications and our estimate for their future expansion is based not only on these present uses but also on increased uses that will come from improved materials having greater outdoor durability and greater heat resistance. The epoxy resins are expected to be used more in unusual and superior types of surface coatings having both chemical and heat resistance, but they will also find great growth as casting resins and as adhesives."

Sulfur

Markets, Methods Face Test

Meet the Author

Mr. Schwartz

Seymour Schwartz, consulting engineer, New York, was born in Brooklyn in 1917. He studied at Polytechnic Institute of Brooklyn and the Illinois Institute of Technology, receiving a degree of M. S. in Ch. E. from the latter in 1940. He studied for a doctor's degree at Virginia Polytechnic Institute and Brooklyn Polytechnic. After working for two chemical companies, where he specialized in sulfur design and evaluation problems, he formed his own company in 1952.

PETROCHEMICAL firms recovering sulfur from hydrogen sulfide, i.e., the producers of Frasch process sulfur, are embroiled in the cross-currents of the sulfur industry because of competition from the Mexican producers. As a consequence, emphasis in sulfur recovery has shifted from day-to-day production difficulties to the shifting of more complex economic problems.

In the past, the incentive of high sulfur prices was a potent driving force to convert flared hydogen sulfide to a salable producet at a good profit. Refiners and natural gas plants rushed to get into production. At the start their main difficulties were operational problems. Today they are concerned with sulfur production trends, plant expansion and pollution problems, higher operating and maintenance costs, lower prices and lower profits.

Production of recovered sulfur, nearly all of which is derived from hydrogen sulfide in natural gas or waste refinery gases, has shown a steady growth from year to year. Starting with the sulfur-shortage years of 1950-1952, as shown in Table I, production has increased rapidly. Last year's record of 401,650 tons is expected to be topped this year by 12%. In 1958 recovered sulfur production is expected to reach 686,000 long tons, up 70% from the 1955 figures.

Unlike Frasch sulfur, the output of recovered sulfur at smaller plants is usually contracted for before the plant is built, and a good selling price, tied to the Gulf Coast quotation for bright yellow sulfur, is almost always assured. Large plants, particularly those located in industrialized areas and within range of low-cost transportation from Gulf ports are in a vulnerable spot.

The growing production of recovered sulfur, including new production from plants, shown in Table II, and stiff competition in the Frasch industry are accentuating the problems of the petrochemical sulfur producers. Nearly all producers, therefore, are faced with the problem of formulating a production and marketing policy to suit their particular needs. These require consideration of plant location and new capacity factors, competitive sources, pollution, etc.

Another source of concern to sulfur plant operators is the higher costs of increased maintenance, high costs and losses in sulfur solidification and transport, and most important of all, a growing awareness that the concentration of hydrogen sulfide and sulfur dioxide in the exit gas, as indicated by conventional methods, is a poor indication of plant efficiency.

The pinch caused by aging plants and lower selling prices has brought new studies by maintenance supervisors. Cost reductions have resulted from the use of alloys, minor changes in equipment and operating conditions, reduction of fouling, and control of plant upsets.

More sulfur is being shipped in liquid form. Where this method is not entirely feasible, sulfur solidification belts, flakers and second-hand soap drums are being used. More economic stockpiling methods include the use of mechanical methods for liquid and solid handling, and the melting down of solid sulfur piles in place.

In the recent past, sulfur plan managements were content to judge the efficiency of their plant by the concentration of H_2S and SO_2 indicated at the stack. Because these constituents react with one another in the presence of water to form elemental sulfur, stack concentrations tend to run low, and indicated conversions to run high. Many a superintendent concluded that his plant was

Table I—Production of Recovered Sulfur in the U. S.

Year	Long Tons	Year	Long Tons
1950	139,352	1951	181,935
1952	249,388	1953	340,827
1954	357,400	1955	401,650
1956	450,000	1957	549,700
1958	686,000		

*1950-1955 incl., U. S. Bureau of Mines
1956-1958 incl., author's estimate

Table II—New Production of Sulfur Recovered from H_2S

Company	Long Tons per Day
Phillips Chemical Co., Andrews County, Texas	60
Hancock Chemical Co., Wilmington, Calif.	100 (e)
Gulf Oil Co., Port Arthur, Texas	65 (e)
Continental Oil Co., Billings, Mont.	15
Union Oil Co., Santa Maria, Calif.	40 (e)
Union Oil Co., Oceano, Calif.	42
Great Northern Oil Co., Pine Bend, Minn.	15
Tide Water Oil Co., Delaware City, Dela.	300
Jefferson Lake Sulphur Co., Fort St. John, B. C.	250
British American Oil Co., Pincher Creek, Alberta	225

(e) Expansion of existing facilities.

doing well enough to hardly warrant further improvement. These so-called conversions ranged from 93 to 99% but actual recovery, based on sulfur in the acid gas and elemental sulfur in the collection pit, often were well below these figures. Many have ranged to below 90%. The discrepancy is attributed to inadequate analytical methods and techniques.

In one medium size plant, tests by operating personnel indicated conversions in excess of 102%. After tests were carried out by the main office engineers and only 99.5% conversion was indicated, the management was satisfied until actual recovery of elemental sulfur was found to be way below this figure.

Perhaps in the future the recovery of sulfur will be looked upon as more than a part-time problem instead of an adjunct of a larger operation, and that the profit on sulfur may warrant greater consideration.

Nitrogen Products

Ammonia Needs Markets

Meet the Authors

Mr. Messing

Mr. Perkins

Richard F. Messing, manager of the Industrial Economic Group, Arthur D. Little, Inc., Cambridge, Mass., graduated in chemical engineering from the University of Minnesota and did graduate work in the Illinois Institute of Technology. Before joining the Little organization in 1945, he was a research engineer with the government's Office of Scientific Research and Development.

Samuel E. Perkins is a graduate in chemical engineering from Massachusetts Institute of Technology and joined the staff of Arthur D. Little, Inc., in 1951. He has specialized in technological and market studies in the chemical industry.

THE producers of synthetic ammonia and other fixed nitrogen products are facing greater marketing and pricing problems than they have faced for many years. Oversupply of nitrogen materials has been accentuated by the agricultural consumption slump coinciding with the capacity jump resulting from completion of new facilities. Although this condition was foreseen, decision in favor of plant construction was made because:

1. The market, particularly in agriculture, was growing rapidly;

2. Each producer believed that the output of one facility represented such a small fraction of the total consumption that it could find its way into the market without upsetting the established pattern; and

3. Geographical factors based on freight absorption have favored entrance of plants designed primarily to serve localized needs.

The U. S. consumption of fixed nitrogen is expected to continue to grow, although at a rate considerably less during the next five years than of the last five years. Consumption of fixed nitrogen in the four general categories of agriculture, industry, military and exports has grown from 1,940,000 tons in the 1950-51 fertilizer year, to an estimated level of 2,850,000 tons in the 1955-56 season just ended. This represents a 910,000-ton increase in consumption in five years. We estimate that consumption in 1960-61, five years hence, will be approximately 3,450,000 tons, an increase of 600,000 tons.

During this ten year period of 1950-60, agriculture will increase its share of nitrogen usage, accounting for 64% in the 1950-51 season, 68% in the 1955-56 season, and an estimated 70% in the 1960-61 season.

The supply of fixed nitrogen in the U. S. comes from four main sources: synthetic ammonia, by-product ammonia, natural organics, and imports. Of these four, synthetic ammonia is by far the most important, and the only realistic area for expansion. By-product ammonia and natural organics represent essentially a fixed quantity, and imports are expected to be reduced in the face of impending oversupply coupled with increased needs in the countries now exporting to the U. S.

In the 1955-56 fertilizer season, synthetic ammonia capacity was larger than total nitrogen consumption by something over 100,000 tons. When other sources of fixed nitrogen are considered, overcapacity was at least 25%. Synthetic ammonia capacity now in existence, plus imports, natural organics, and by-product nitrogen, already exceeds the estimated total demand five years hence.

Despite the continuing prospect for oversupply of nitrogen products, several companies are planning to build new facilities. Total U. S. ammonia capacity Jan. 1, 1956 was 3,719,000 tons, 3,065,000 tons for nitrogen. By the end of 1956 ammonia capacity will be 4,570,000 tons, nitrogen 3,765,000 tons. Some 500,000 tons additional ammonia capacity is either financed or proposed.

The ratio of nitrogen used in mixed fertilizers to nitrogen used for direct application has decreased since 1947, when mixed fertilizers represented about 60% of total agricultural nitrogen, and straight nitrogen materials represented 40%. by 1950, half of the nitrogen was contained in each of these forms, and by 1960, 60% of fertilizer nitrogen is expected to be in the form of straight materials.

Ammonium nitrate is an important form of fixed nitrogen, and its use has been growing each year. Demand for this product is expected to increase because of its high nitrogen content, which reduces freight and handling costs per unit of nitrogen. The producers of urea, a product containing about 30% more nitrogen than ammonium nitrate, are now trying to captalize on this same factor. If the price of urea is reduced to a level comparable with ammonium nitrate on the nitrogen basis, it will undoubtedly cut into the sales of ammonium nitrate.

The other agricultural chemicals derived from natural gas and petroleum are negligible in the total petrochemicals picture. Examples such as ethylene oxide going into ethanol amines for 2,4-D esters, and chlorinated cyclopentadiene for insecticides are small compared with consumption in such major outlets as rubber, plastics, surface coatings, and solvents. General improvement occurring in the agricultural chemical field should, of course, be reflected in large usage of products such as benzene, ethyl alcohol, ethylene dibromide and cyclopentadiene.

Construction—Over $1-Billion

Fifth annual study shows 197 companies with 362 plants—operating, building, or planned

OVER $1-billion is currently being invested in new facilities to make petrochemicals in the U. S. and Canada, according to PETROLEUM PROCESSING's fifth annual survey of petrochemical plants.

The study, completed just before press time for this issue, also showed that:

- There are now 197 companies and 362 petrochemical plants in the two countries in operation, under construction, or being planned. This is 10 companies (+5.3%), and 35 plants (+9.7%) more than the figures showed last year.
- Of the 197 companies, 59 are petroleum firms or their subsidiaries, 86 are petrochemical companies, 49 are chemical, and 3 are joint ventures of petroleum and chemical firms.
- There are 56 entirely new plants under construction or planned, representing an estimated new investment of $539-million.
- In addition, 59 expansion projects at existing plants are planned or under way, for an estimated investment of $509-million.
- Project completions since the last survey by PETROLEUM PROCESSING a year ago number 40 plants.
- New companies now being reported in the petrochemical industry since the 1955 survey total 17. Some of these are brand new companies established during the past 12 months; others are existing firms that have gone into petrochemicals.

It should be pointed out that it is impossible to make a fair comparison of trends within segments of the industry from year to year. This is because shifts and transitions have taken place that necessitate continuous updating and reclassification of some plants or companies as chemical firms merge with or purchase petroleum firms, or vice versa.

Another factor that changes the overall picture is the dropping of certain projects that may have been completely firm and definite a year ago.

Details on the entire petrochemical industry are provided in the following pages. Information in this directory has been furnished by the individual companies, augmented with data from other sources.

A new feature has been added to the alphabetical products list, which begins on p. 133. As it did in 1955, this index lists all petrochemicals reported in the directory. In addition, this year the index provides a brief description of most of the products listed. (For further details see box at bottom of this page.)

Petrochemical Plants in the U.S.

A

AETNA OIL CO. 1
Louisville, Ky.
Remarks: A subsidiary of Ashland Oil & Refining Co. No definite plans announced, but company is doing pilot plant research and development in petrochemicals.

ALLIED CHEMICAL & DYE CORP.
(Barrett Division) 2
Frankford, Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Phenol—30,000,000 lb/yr
Personnel: Thomas Lee, mgr.; J. C. Shea, supt.; J. T. Keating, chief engr.

ALLIED CHEMICAL & DYE CORP.
(General Chemical Division) 3
El Segundo, Calif.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfuric acid—150,000 ton/yr
Personnel: J. V. Cales, mgr.; W. B. Yarborough, chief engr.
Remarks: Refinery gases are supplied by Standard Oil Co. of California.

ALLIED CHEMICAL & DYE CORP.
(General Chemical Division) 4
Richmond, Calif.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfuric acid—100,000 ton/yr
Personnel: D. L. Hicken, mgr.; W. B. Yarborough, chief engr.
Remarks: Refinery gases supplied by Standard Oil Co. of California.

ALLIED CHEMICAL & DYE CORP.
(National Aniline Division) 5
Buffalo, N. Y.
Hydrocarbon raw materials:
Kerosine
Products and output:
Synthetic detergents
Personnel: J. F. Daly, mgr.; B. R. MacKinnon, supt.; H. W. Busch, chief, engr.

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 133-140. Products are listed alphabethically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 300 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

ALLIED CHEMICAL & DYE CORP.
(Nitrogen Division) 6
La Platte, Neb.
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—75,000 ton/yr
Urea—110,000 ton/yr
Personnel: R. L. Riggs, mgr.; V. A. Perringer, supt.; I. H. Novikoff, chief engr.

ALLIED CHEMICAL & DYE CORP.
(Nitrogen Division) 7
South Point, Ohio
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—320,000 ton/yr
Urea—80,000 ton/yr
Methanol—53,500 ton/yr
Formaldehyde—42,500 ton/yr (100%)
Personnel: C. W. Bahrt, Jr., mgr.; G. E. Brandon, Jr., supt.; J. H. Critcher, chief engr.

ALLIED CHEMICAL & DYE CORP.
(Nitrogen Division) 8
Orange, Texas
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylene oxide—12,000 ton/yr
Ethylene glycol—16,000 ton/yr
Ethanolamines
Personnel: E. L. Roy, manager; H. Lanier, superintendent; J. E. Hollis, Jr., chief engr.

ALLIED CHEMICAL & DYE CORP. (Nitrogen Division) 9
Hopewell, Virginia
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—400,000 ton/yr
Personnel: F. A. Ernst, manager; S. G. Mckenzie, superintendent; W. L. E. Dewling, chief engr.

ALLIED CHEMICAL & DYE CORP. (Semet-Solvay Division) 10
Tonawanda, New York
Hydrocarbon raw materials:
Ethylene (from fuel oil)
Fuel oil
Products and output:
Polyethylenes—20,000,000 lb/yr
Butadiene—8,000,000 lb/yr
Propylene—10,000,000 lb/yr
Personnel: W. J. Wixson, superintendent; H. D. Enderson, chief engineer
Remarks: Crude light oils are recovered and refined at another location. Polyethylene facilities represent a $10-million investment.

ALLIED CHEMICAL & DYE CORP. (Solvay Process Division) 11
Mouridsville, W. Virginia
Hydrocarbon raw materials:
Natural gas
Products and output:
Methyl chloride
Methylene chloride
Chloroform
Carbon tetrachloride
Total—11,500 ton/yr
Personnel: W. E. Dugan, manager; C. D. Smith, superintendent

ALOX CORP. 12
Niagara Falls, New York
Hydrocarbon raw materials:
Oxygenated petroleum hydrocarbons
Products and output:
Rust preventives, oil and cutting oil additives, total—12,500,000 lb/yr
Personnel: C. A. Weltman, manager; E. F. Tiegerman, superintendent
Remarks: Company taken over in June by Montgary Explorations, Ltd., of Toronto, Ontario. A $1,650,000 expansion program is underway, adding such products as corrosion inhibitors, petroleum and synthetic sulfonates, and additives for lube oils, motor fuels, diesel fuels, jet fuels. Girdler Corp. is building some of the new equipment.

AMERICAN CYANAMID CO. 13
Avondale, La.
Approximate investment: $50,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—109,000 ton/yr
Acetylene
Hydrocyanic acid
Acrylonitrile
mono methyl styrene—40,000,000 lb/yr
Personnel: C. F. Bonnet, manager; R. J. Turner, res. tech. director; E. F. Grieb, operations manager; J. I. Davidson, mgr. of plant service
Remarks: Company started $39,000,000 program to double acrylonitrile capacity in April, 1956. Completion expected late 1957.

AMERICAN OIL CO. 14
Texas City, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Plasticizers
Polymers and resins
Benzene
Toluene
Xylene
Methyl mercaptan—5,000,000 lb/yr
Personnel: B. F. Babin, manager

AMERICAN SYNTHETIC RUBBER CORP. 15
Louisville, Ky.
Approximate investment: $2,340,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
GR-S rubber—44,000 ton/yr
Personnel: R. W. MacFarlane, production manager; F. J. Sackfield, technical superintendent; E. W. Zipfel, plant engineer
Remarks: Will increase capacity to approximately 68,000 ton/yr. Completion scheduled for first quarter 1957. Walter Kidde Constructors, Inc., has contract.

ATLANTIC REFINING CO. 16
Philadelphia, Penna.
Approximate investment: $5,500,000
Hydrocarbon raw materials:
Natural gas
Petroleum fractions
Refinery gases
Products and output:
Ammonia—30,000 ton/yr
Synthetic detergents
Sulfuric acid
Personnel: D. T. Shaw, manager

ATLANTIC REFINING CO. 17
Atreco, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic detergents
Personnel: R. Stewart, manager

ATLAS POWDER CO. 18
Location undecided
Approximate investment: $6,750,000
Hydrocarbon raw materials:
Petroleum hydrocarbons
Products and output:
Ammonia
Remarks: Plant still in planning stage. Certificate of necessity has expired, and no request for renewal is presently pending.

ATLAS PROCESSING CO. 19
Shreveport, La.
Approximate investment: $5,975,000
Gross value, products: 1955—$4,665,000
(est.) 1956—$4,665,000
Hydrocarbon raw materials:
Petroleum naphtha
Products and output:
Benzene—560 b/d
Personnel: V. B. Chance, president & manager; W. L. Hiller, superintendent; R. L. Chatham, process engineer

AURORA GASOLINE CO. 20
Detroit, Mich.
Approximate investment: $250,000
Hydrocarbon raw materials:
Refinery streams
Products and output:
Sulfur—9,900 ton/yr
Personnel: B. Blasco, superintendent; H. J. Oberding, chief engineer

AURORA GASOLINE CO. 21
Muskegon, Mich.
Personnel: R. E. McCarty, superintendent
Remarks: Platforming unit of 1500 b/d capacity making motor fuel stocks only at present.

B

BAKELITE CO. 22
Marietta, Ohio
Approximate investment: $2,722,000
Products and output:
Styrene
Remarks: Raw materials include BOTH petroleum and non-petroleum sources.

BARIUM REDUCTION CORP. 23
South Charleston, West Va.
Hydrocarbon raw materials:
Natural Gas
Products and output:
Carbon bisulfide
Hydrogen sulfide
Sodium sulfhydrate
Sulfur
Personnel: L. Preisman, manager; C. F. Hobson, superintendent; E. W. Wick, Jr., chief engr.

BARNHART HYDROCARBON CORP. 24
Big Lake, Texas
Remarks: Former channel black plant. Shut down in Sept., 1954.

THE BORDEN CO. (Chemical Division) 25
Fayetteville, No. Carolina
Hydrocarbon raw materials:
Methanol
Products and output:
Formaldehyde—36,000,000 lb/yr
Personnel: E. J. Sullivan, manager; D. R. Long, chief engineer

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. . . plus descriptions of 300 petrochemicals

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Remarks: Under construction. Completion expected late this year.

THE BORDEN CO. (Chemical Division) 26
Kent, Washington
Hydrocarbon raw materials:
Methanol
Products and output:
Formaldehyde—36,000,000 lb/yr
Personnel: R. T. Hanson, manager; B. Butler, chief engineer
Remarks: Under construction. Completion expected late this year.

BRAY CHEMICAL CO. 27
Los Angeles, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lubricating oil additives
Petroleum sulfonates—15,000,000 lb/yr
Personnel: R. P. Schuster, manager; C. N. Whitaker, chief engineer

BREA CHEMICALS, INC. 28
Brawley, Calif.
Remarks: Plans cancelled for ammonium phosphate plant at this location.

BREA CHEMICALS, INC. 29
Brea, Calif.
Approximate investment: $18,000,000
Gross value, products: 1955—$11,000,000
(est.) 1956—$14,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—86,000 tons/yr
Nitric acid (100% basis)—44,000 tons/yr
Ammonium nitrate—55,000 tons/yr
Ammonium phosphate—25,000 tons/yr
Dry ice and carbon dioxide—27,000 tons/yr
Personnel: R. S. Ogilvie, superintendent

BREA CHEMICALS, INC. 30
Fresno, Calif.
Approximate investment: $100,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonium phosphate—17,000 ton/yr

BREA CHEMICALS, INC. 31
Los Angeles County, near Wilmington, Calif.
Approximate investment: $20,000,000
Hydrocarbon raw materials:
Propane
Products and output:
Polyethylene—60,000,000 lbs/yr
Remarks: Joint venture with Koppers Co., Inc. Capacity shown is ultimate. Plant now in planning stage. Completion scheduled for Sept., 1957.

BRIN CHEMICAL CORP. 32
Tulsa, Okla.
Approximate investment: $100,000
Hydrocarbon raw materials:
Refinery wastes
Products and output:
Phenols
Xylenols
Cresylic acids
Personnel: B. T. Brown, manager; D. N. Irwin, chief engineer

BRYTON CHEMICAL CO. 33
Trainer, Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Oil-soluble sulfonates
Personnel: E. W. Carlson, manager; C. H. Blouch, superintendent; D. A. Wilkie, chief engineer
Remarks: Plant is owned by Continental Oil Co., operated by Bryton.

C

CABOT CARBON CO. 34
Franklin, La.
Hydrocarbon raw materials:
Petroleum residues
Natural gas
Products and output:
Carbon blacks—157,000,000 lb/yr
Personnel: D. C. Paulsen, manager; H. S. Ayres, superintendent

CABOT CARBON CO. 35
Ville Platte, La.
Hydrocarbon raw materials:
Petroleum residues
Natural gas
Products and output:
Furnace blacks—129,000,000 lb/yr
Personnel: R. D. Gibson, manager; R. T. Bowen, superintendent

PETROCHEMICALS
1956 REPORT

CABOT CARBON CO. 36
Hobbs, New Mexico
Remarks: Plant dismantled. Cabot has discontinued all operations at Hobbs.

CABOT CARBON CO. 37
Guymon, Okla.
Remarks: Plant dismantled. Cabot has discontinued all operations at Guymon.

CABOT CARBON CO. 38
Big Spring, Texas
Hydrocarbon raw materials:
Petroleum residues
Products and output:
Oil furnace blacks—67,300,000 lb/yr
Personnel: A. R. Davenport, manager

CABOT CARBON CO. 39
Kermit, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks—28,000,000 lb/yr
Personnel: B. F. Bulls, manager

CABOT CARBON CO. 40
Kingsmill, Texas
Remarks: Plant dismantled. Cabot has discontinued all operations at Kingsmill.

CABOT CARBON CO. 41
Pampa, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Furnace blacks—51,000,000 lb/yr
Personnel: E. J. O'Brient, manager

CABOT CARBON CO. 42
Skellytown, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks for rubber, ink, and paint
Total—27,000,000 lb/yr
Personnel: W. L. Marshall, manager, Plant A; J. M. Brown, manager, Plant B.

CABOT CARBON CO. 43
Stinnett, Texas
Remarks: Plant dismantled. Cabot has discontinued all operations at Stinnett.

CABOT CARBON CO. 44
Wickett, Texas
Remarks: Plant dismantled. Cabot has discontinued all operations at Wickett.

CALIFORNIA SPRAY CHEMICALS CO. 45
Richmond, Calif.
Hydrocarbon raw materials:
Petroleum bases
Products and output:
n-Trichloromethylmercapto-4-cyclohexene-1, 2-dicarboximide
n-Butyl, 2, 4—dichlorophenoxyacetate
Isopropyl, 2, 4-dichlorophenoxyacetate
2, 4-dichlorophenoxy-acetic acid, dimethylamine salt
Tetrahydrofurfuryl, 2, 4, 5-trichlorophenoxy-acetate
Tetraethyl pyrophosphate
Ethylene glycol mono-oleate
Personnel: E. W. Cannon, vice president
Remarks: Subsidiary of Standard Oil Co. of California. A $16,000,000, 300 ton-day fertilizer plant is scheduled for completion in October, 1956.

CALUMET NITROGEN PRODUCTS CO. 46
Hammond, Ind.
Approximate investment: $9,000,000
Hydrocarbon raw materials:
Reformer off-gas
Products and output:
Anhydrous ammonia—109,500 ton/yr
Nitrogen solutions—36,500 ton/yr
Remarks: By-product hydrogen to be obtained from Std. Oil (Ind.) refinery at Whiting, Ind. and Sinclair, East Chicago, Ind. refineries. Indiana Std. to operate. New Company is jointly owned (55% Indiana Std. & 45% Sinclair). Plant scheduled for completion in fall of 1956.

CARBIDE & CARBON CHEMICALS CO. 47
Torrance, Calif.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Polyethylene—60,000,000 lb/yr
Ethylene glycol—10,000,000 gal/yr
Ethylene oxide
Personnel: C. N. Rucker, superintendent

CARBIDE AND CARBON CHEMICALS CO. 48
Whiting, Ind.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Ethylene glycol
Isopropanol
Acetic acid and anhydride
Personnel: R. P. Bradley, superintendent

CARBIDE & CARBON CHEMICALS CO. 49
Seadrift, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Ethylene glycol
Polyethylene
Ethylene oxide
Butadiene
Personnel: C. M. Blair, Jr., superintendent
Remarks: Plant adding capacity for additional 65-million lb/yr of ethylene glycol, a $43,000,000 investment. Completion scheduled for fall 1956. A $4.5-million ethanolamines plant also is being built.

CARBIDE & CARBON CHEMICALS CO. 50
Texas City, Texas
Hydrocarbon raw materials:
Natural and refinery gases
Products and output:
Polyethylene—60,000,000 lb/yr
Ethylene-amines
Alcohols
Glycols
Acetone
Acetic acid and anhydride
Vinyl resins
Acetylene
Personnel: T. A. Wilker, superintendent
Remarks: Production of vinyl acetate to be doubled at completion of current expansion program, scheduled for fall, 1956.

CARBIDE & CARBON CHEMICALS CO. 51
Institute, W. Va.
Hydrocarbon raw materials:
Natural gas
Products and output:
Ethanol
Butanol
2-ethylhexanol
Glycols
Acetic acid and anhydride
Styrene
Polyethylene
Plasticizers
Personnel: C. H. Atwood, superintendent

CARBIDE & CARBON CHEMICALS CO. 52
So. Charleston, W. Va.
Hydrocarbon raw materials:
Natural and refinery gases
Products and output:
Alcohols
Glycols
Ethers and oxides
Esters
Ketones
Aldehydes
Acetals
Anhydrides
Vinyl resins
Polyethylene—70,000,000 lb/yr
Plasticizers
Wetting agents
Personnel: F. H. Belden, superintendent

CARBON BLACKS, INC. 53
Rayville, La.
Approximate investment: $100,000
Gross value, products, 1955: $100,000 (est.) 1956: $125,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon black—720,000 lb/yr
Personnel: J. H. Mann, Jr., president; J. H. Mann, Sr., treas. & gen. manager

CARLISLE CHEMICAL WORKS, INC. 54
Jersey City, N. J.
Hydrocarbon raw materials:
Petroleum fractions
Naphthenic acid
Products and output:
Lead naphthenate
Lube additives (extreme pressure type)
Esters of petroleum derivatives
Personnel: H. E. Klotz, chief engineer

CARLISLE CHEMICAL WORKS, INC. 55
Reading, Ohio
Hydrocarbon raw materials:
Petroleum fractions
Naphthenic acid
Products and output:
Lead naphthenate
Lube additives (extreme pressure type)
Esters of petroleum derivatives
Personnel: W. R. Hawkins, superintendent; H. E. Klotz, chief engineer

CARTHAGE HYDROCOL, INC. 56
(See Hidalgo Chemical Co.)

CELANESE CORP. OF AMERICA 57
Bishop, Texas
Hydrocarbon raw materials:
Propane and butane
Products and output:
Methanol
n-Propanol
Formaldehyde
Paraformaldehyde
Acetaldehyde
Acetic acid
Acetone
Butylene glycol
Propylene oxide and glycol
Dipropylene glycol
Trioxane
Iso- and n-butanol
Iso-butyl, n-butyl, and n-propyl acetate
Methylal
Ethylene glycol diacetate
Personnel: E. T. Lindsey, manager
Remarks: Construction underway for 25% increase in production of formaldehyde, methanol, acetaldehyde, and other organic chemicals. Completion scheduled for early 1957.

CELANESE CORP. OF AMERICA 58
Pampa, Texas
Hydrocarbon raw materials:
Propane and butane
Products and output:
Acetaldehyde
Acetic acid and anhydride
Vinyl acetate—30,000,000 lb/yr
Propionic and butyric acid
Methanol and solvents
Methyl ethyl ketone
Personnel: J. F. Frick, manager
Remarks: Vinyl acetate capacity to be doubled.

CELANESE CORP. OF AMERICA 59
Houston, Texas
Approximate investment: $10,000,000
Products and output:
Polyethylene—40,000,000 lb/yr
Remarks: Planned for construction on 220-acre site south of San Jacinto State Park on Houston Ship Channel. Phillips process to be used. Completion in early 1957.

CELANESE CORP. OF AMERICA 60
Gallipolis Ferry, West Virginia
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Tricresyl phosphate
Plasticizers
Functional fluids
Remarks: Plant was completed in April, 1956. Uses raw materials from Bishop and Pampa, Texas, plants plus some coal-tar hydrocarbons.

CHEMSTRAND CORP. 61
Decatur, Ala.
Hydrocarbon raw materials:
Natural gas
Products and output:
Acrylonitrile

CHEMSTRAND CORP. 62
Pensacola, Florida
Hydrocarbon raw materials:
Natural gas
Cyclohexane
Products and output:
Nylon—88,000,000 lb/yr
Personnel: R. G. Hemminghaus, vice president; Fred G. Gronemeyer, manager

CITIES SERVICE REFINING CORP. 63
Lake Charles, La.
(See Petroleum Chemicals, Inc., who bought butadiene plant.)

CITIES SERVICE OIL CO. (Del.) 64
Oklahoma City, Oklahoma
Remarks: Plant shut down Dec. 31, 1955, and since dismantled.

CITIES SERVICE OIL CO. (Del.) 65
Tallant, Oklahoma
Remarks: Plant shut down Dec. 31, 1955, and since dismantled.

COLUMBIA RIVER CHEMICALS, INC. 66
Attalia, Wash.
Approximate investment: $12,600,000
Hydrocarbon raw materials:
Bunker C fuel oil
Products and output:
Anhydrous ammonia—57,600 ton/yr
Ammonium sulfate—50,400 ton/yr
Urea—39,600 ton/yr
Remarks: Reported still in planning stage, though project is temporarily held in abeyance.

COLUMBIA-SOUTHERN CHEMICAL CORP. 67
Barberton, Ohio
Hydrocarbon raw materials:
Propylene

Acetylene
Products and output:
Perchloroethylene
Trichloroethylene
Personnel: W. S. Straub, manager

COLUMBIA-SOUTHERN CHEMICAL CORP. 68
Natrium, W. Va.
Hydrocarbon raw materials:
Hydrogen
Benzene
Products and output:
Anhydrous ammonia
Mono-chloro-benzene
Di-chloro-benzene
Benzene-hexa-chloride
Personnel: C. E. Wolf, manager

COLUMBIAN CARBON CO. 69
El Dorado, Ark.
Approximate investment: $2,600,000
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—70,000,000 lb/yr
Personnel: B. H. Cobb, supervisor

COLUMBIAN CARBON CO. 70
Hickok, Kans.
Approximate investment: $1,900,000
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—31,200,000 lb/yr
Personnel: J. W. Buchanan, superintendent

COLUMBIAN CARBON CO. 71
Eola, La.
Approximate investment: $1,400,000
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—38,500,000 lb/yr

COLUMBIAN CARBON CO. 72
Franklin, La.
Approximate investment: $3,500,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Furnace black—42,000,000 lb/yr
Personnel: J. W. Norris, Jr., supervisor

COLUMBIAN CARBON CO. 73
Hancock, La.
Remarks: An experimental pilot plant, operating on natural gas to produce furnace blacks

COLUMBIAN CARBON CO. 74
Eunice, N. Mex.
Approximate investment: $1,500,000
Hydrocarbon raw materials:
Natural and casinghead gas
Products and output:
Channel black—24,500,000 lb/yr
Personnel: C. E. Thompson, superintendent

COLUMBIAN CARBON CO. 75
Coltexo, Texas
Approximate investment: $680,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel black—4,260,000 lb/yr
Personnel: Bernard Johnson, superintendent, main plant; Howard Johnson, superintendent, plant 2.

COLUMBIAN CARBON CO. 76
Conroe, Texas
Approximate investment: $3,100,000
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—71,750,000 lb/yr
Personnel: C. C. May, supervisor

COLUMBIAN CARBON CO. 77
Corpus Christi, Texas
Approximate investment: $547,000
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Channel black—7,300,000 lb/yr
Personnel: J. A. Aulds, superintendent

COLUMBIAN CARBON CO. 78
Fortune, Texas
Remarks: Furnace black plant, idle since March 25, 1955.

COLUMBIAN CARBON CO. 79
Kingsmill, Texas
Remarks: Channel black plant, idle since July, 1954.

COLUMBIAN CARBON CO. 80
Lefors, Texas
Approximate investment: $1,300,000
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Channel black—25,000,000 lb/yr
Personnel: N. C. Jordan, supervisor

COLUMBIAN CARBON CO. 81
Seagraves, Texas
Approximate investment: $1,600,000
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—49,000,000 lb/yr
Personnel: R. Fowler, supervisor

COLUMBIAN CARBON CO. 82
Seminole, Texas
Approximate investment: $2,300,000
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Channel black—27,000,000 lb/yr
Sulfur
Personnel: J. E. Earhart, supervisor

COLUMBIAN CARBON CO. 83
Sunray, Texas
Remarks: Channel black plant, idle since Aug., 1953.

COLUMBIAN CARBON CO. 84
Sweeney, Texas
Approximate investment: $628,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon black—1,092,000 lb/yr
Personnel: E. Johnson, supervisor

COMMERCIAL SOLVENTS CORP. 85
Peoria, Illinois
Hydrocarbon raw materials:
Natural gas
Products and output:
Nitroparaffins
Personnel: T. M. Walton, manager

COMMERCIAL SOLVENTS CORP. 86
Sterlington, La.
Approximate investment: $45,000,000
Hydrocarbon raw materials:
Natural gas and propane
Products and output:
Ammonia—135,000 ton/yr
Methanol
Ammonium nitrate solutions
Solid ammonium nitrate fertilizer
Nitroparaffin—10,000,000 lb/yr
Personnel: J. E. Wheeler, general manager, production, petrochemicals division
Remarks: $10-million program underway to increase production of methanol and petrochemical derivatives.

CONSOLIDATED CARBON CORP. OF ILL. 87
(See Lynn Carbon Black Co.)

CONSOLIDATED CHEMICAL INDUSTRIES, INC. 88
Remarks: All operations purchased by Stauffer Chemical Co. in November, 1955. See Stauffer Chemical Co. (Consolidated Chemical Division)

CONTINENTAL BLACKS, INC. 89
Westlake, La.
Hydrocarbon raw materials:
Refractory refinery cycle stock
Products and output:
Carbon black—40,000,000 lb/yr
Personnel: R. A. Reinke, manager; W. Fergus, superintendent

CONTINENTAL BLACKS, INC. 90
Ponca City, Okla.
Hydrocarbon raw materials:
Refractory refinery cycle stock
Products and output:
Carbon black—60,000,000 lb/yr
Personnel: R. A. Reinke, manager; F. Forbes, superintendent

CONTINENTAL CARBON CO. 91
Eunice, New Mex.
Hydrocarbon raw materials:
Natural gas
Products and output:
SRF black—25,000,000 lb/yr
Channel black—50,000,000 lb/yr
Personnel: R. A. Reinke, manager

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 133-140. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 300 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

CONTINENTAL CARBON CO. 92
Sunray, Texas
Hydrocarbon raw materials:
Dry natural gas
Refractory refining cycle stock
Products and output:
Carbon blacks
Personnel: O. Middlebrooks, general manager

CONTINENTAL OIL BLACK CO. 93
(See Continental Blacks, Inc.)

CONTINENTAL OIL CO. 94
Chicago, Ill.
Hydrocarbon raw materials:
Dodecylbenzene
Products and output:
Water soluble sulfonates
Oil fracturing compounds
Personnel: K. R. Gerhart, superintendent

CONTINENTAL OIL CO. 95
Lake Charles, La.
Approximate investment: $2,700,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene
Toluene
Dodecene
Personnel: J. M. Jones, manager
Remarks: Dodecene and benzene are delivered to the Continental petrochemical plant at Baltimore, Md., where dodecylbenzene is produced for the detergent industry.

CONTINENTAL OIL CO. 96
Baltimore, Md.
Hydrocarbon raw materials:
Benzene
Dodecene
Products and output:
Synthetic detergent base stock
Personnel: W. O. Miller, superintendent

CONTINENTAL OIL CO. 97
Ponca City, Okla.
Approximate investment: $7,500,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene and other aromatic mixtures (as reformate)—3850 b/d
Personnel: C. D. Hull, manager
Remarks: New 10,000 b/d Platformer scheduled for completion, July, 1957.

CONTINENTAL OIL CO. (Sherwood Refining Division) 98
Gretna, Louisiana
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Petroleum sulfonates
Personnel: H. H. Morse, superintendent
Remarks: Company purchased former plant of Sherwood Refining Co. in March, 1956.

CONTINENTAL OIL CO. (Sherwood Refining Division) 99
Karns City, Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Refined petrolatum
Personnel: E. J. Karwacki, superintendent
Remarks: Continental purchased former plant of Sherwood Refining Co. in March, 1956.

COOPERATIVE FARM CHEMICALS ASSN. 100
Lawrence, Kansas
Approximate investment: $16,000,000
Gross value, products: 1955—$3,500,000 (est.) 1956—$8,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—13,200 ton/yr
Ammonium nitrate—83,000 ton/yr
Nitrogen solutions—13,200 ton/yr
Personnel: R. R. Zurbuchen, manager; C. C. Chaffee, superintendent; A. D. Farnelli, chief engineer.

COPOLYMER RUBBER & CHEMICAL CORP. 101
Baton Rouge, La.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Butylene
Styrene
Products and output:
Butadiene—23,000 ton/yr
GR-S synthetic rubber—49,000 ton/yr
Personnel: Col. G. M. Hulings, exec. vice president; T. B. Crowell, superintendent; C. M. McKay, chief engineer
Remarks: Current expansion underway will increase butadiene to 35,000 ton/yr, and GR-S to 68,800 ton/yr by July, 1957.

COSDEN PETROLEUM CORP. 102
Big Spring, Texas
Approximate investment: $6,000,000

Gross value, products: 1955—$4,500,000
Hydrocarbon raw materials:
Aromatics from Platformer
Depentanized straight run gasoline
LPG fraction
Cycle stock
Mixed xylenes
Products and output:
Benzene—54,000 bbl/yr
Toluene—144,000 bbl/yr
Xylene—200,000 bbl/yr
Polyisobutylenes—1,000,000 gal/yr
Styrene monomer—20,000,000 lb/yr
Personnel: Dan M. Krauss, general manager; George Grimes, superintendent; E. B. McCormick, chief engineer
Remarks: Styrene plant construction underway; completion scheduled for Feb., 1957. Badger Mfg. Co. has contract.

D

DEERE & CO.
(Grand River Chemical Division) 103
Pryor, Oklahoma
Approximate investment: $18,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—65,850 ton/yr
Urea—90,000 ton/yr
Personnel: W. W. Yeandle, gen'l manager; J. E. Dew, chief engineer; R. B. Ady, tech mgr.

DELHI TAYLOR OIL CORP. 104
Corpus Christi, Texas
Hydrocarbon raw materials:
Crude oil and distillate
Products and output:
Aromatics
Personnel: F. A. Reneau, superintendent
Remarks: Refinery not running presently for production of petrochemicals. Aromatics being used in motor fuel.

DIAMOND ALKALI CO.
(Chlorinated Products Division 105
Newark, N. J.
Hydrocarbon raw materials:
Benzene
Products and output:
Hexachlorobenzene
Chloral
Miticides
2, 4-D
2, 4, 5-T
DDT
Benzene sulfonyl chloride
Dichlorphenol
Trichlorphenol
Organic intermediates
Muriatic acid
Personnel: John Burton, manager; S. R. Trocki, superintendent

DIAMOND ALKALI CO.
(Chlorinated Products Division 106
Painesville, Ohio
Hydrocarbon raw materials:
Paraffin wax
Products and output:
Chlorinated paraffin, liquid and resinous
Carbon tetrachloride
Anhydrous hydrogen chloride
Personnel: R. C. Rahn, manager

DIAMOND ALKALI CO.
(Chlorinated Products Division 107
Deer Park, Houston, Texas
Hydrocarbon raw materials:
Ethylene
Products and output:
Vinyl chloride
Ethylene dichloride
Perchlorethylene
Paraffin solvent
Anhydrous hydrogen chloride
Personnel: H. S. Weiner, manager
Remarks: Company doubling present capacity for perchlorethylene; completion scheduled for April, 1957. Expansion program also includes new ethylene dichloride facilities.

DIAMOND ALKALI CO.
(Chlorinated Products Division) 108
Greens Bayou, Houston, Texas
Hydrocarbon raw materials:
Benzene
Products and output:
Benzene hexachloride
Lindane
DDT
Hexachlorobutadiene
Hexachloroethane
Muriatic acid
Personnel: R. J. Koll, manager; L. W. Hindes, superintendent; R. Seimoneit, chief engineer

DIAMOND ALKALI CO.
(Chlorinated Products Division) 109
Belle, W. Va.
Hydrocarbon raw materials:
Natural gas
Products and output:
Methyl chloride
Methylene chloride
Chloroform
Muriatic acid
Personnel: R. L. Muehlman, manager

DOW CHEMICAL CO. 110
Pittsburg, Calif.
Hydrocarbon raw materials:
Natural gas
Styrene
Butadiene
Products and output:
Methylene chloride
Methyl chloride
Chloroform
Carbon tetrachloride
Perchloroethylene
Synthetic rubber latex
Personnel: M. F. Ohman, manager of operations
Remarks: Latex plant scheduled for completion this fall.

DOW CHEMICAL CO. 111
Torrance, Calif.
Hydrocarbon raw materials:
Styrene
Products and output:
Polystrene
Personnel: Daniel W. Ryan, general manager
Remarks: Additional polystyrene capacity was added to Torrance in 1956.

DOW CHEMICAL CO. 112
Allyn's Point, Conn.
Hydrocarbon raw materials:
Styrene
Products and output:
Polystyrene
Personnel: K. E. Stober, manager

DOW CHEMICAL CO. 113
Baton Rouge-Plaquemine area, La.
Remarks: Company in June exercised an option to purchase a site in this area. Overall plans are for $20-million worth of expansion in Louisiana. Production of some petrochemical derivatives is probable.

DOW CHEMICAL CO. 114
Midland, Mich.
Hydrocarbon raw materials:
Ethylene
Propylene
Benzene
Products and output:
Styrene
Butadiene
Alpha methyl styrene
Ethylene glycol
Ethylbenzene
Ethyl chloride
Ethylene dibromide
Diethyl benzene
Divinyl benzene
Ethylene dichloride
Dichlorethylether
Ethylene oxide
Mono-, di-, and tri-ethanolamine
Ethylene diamine
Isopropyl benzene
Isopropyl chloride
Propylene glycol
Propylene oxide
Propylene dichloride
Isopropanolamines
Polyglycols
Polyglycol ethers
Polyvinylidene chloride
Ethyl cellulose
Methyl cellulose
Polyvinyl chloride
Vinyl toluene
Styrene butadiene latex—55,000,000 lb/yr
Personnel: W. H. Schuette, general manager

DOW CHEMICAL CO. 115
Pevely, Mo.
Hydrocarbon raw materials:
Styrene
Products and output:
Polystyrene
Personnel: R. E. Reinker
Remarks: Under construction. Completion scheduled for fall of 1956.

DOW CHEMICAL CO. 116
Ironton, Ohio
Hydrocarbon raw materials:
Styrene
Products and output:
Polystyrene
Personnel: M. H. Weymouth, manager
Remarks: Under construction. Completion scheduled for fall of 1956.

DOW CHEMICAL CO. (Texas Division) 117
Freeport and Velasco, Texas
Hydrocarbon raw materials:
Butadiene
Methane (natural gas)
Ethylene and propylene
Benzene
Products and output
Styrene
Methyl Chloride
Ethyl chloride
Ethylene dichloride
Vinyl chloride
Carbon tetrachloride
Chloroform
Ethylene glycol
Diethylene glycol
Triethylene glycol
Tetraethylene glycol
Propylene glycol
Perchloroethylene
Trichloroethylene
Dichlorethyl ether
Dichlorisopropyl ether
Ethylene oxide
Propylene oxide
Latex
Methyl chloroform
Methylene chloride
Polyglycol
Propylene dichloride
Styrene oxide
Toluene
Vinylidene chloride
Butadiene
Glycerol
Polyethylene
Personnel: A. P. Beutel, general manager
Remarks: Current $45-million expansion program to include new units for acetylene, methylacetylene, ethanolamines, synthetic glycerine, glycol, perchlorethylene, styrene, chlorine. Completion planned for early 1958.

E. I. DU PONT DE NEMOURS & CO. 118
Antioch, Calif.
Products and output:
Tetraethyl lead
Ethyl chloride
Freon 11 Trichloromonofluoromethane
Freon 12 Dichlorodifluoromethane refrigerants
Sodium
Trichlorethylene
Perchlorethylene
Remarks: Completion scheduled for early 1957.

E. I. DU PONT DE NEMOURS & CO., INC. 119
Memphis, Tenn.
Hydrocarbon raw materials:
Natural gas
Products and output:
Hydrogen cyanide
Personnel: T. D. Bell, manager

E. I. DU PONT DE NEMOURS & CO., INC. 120
Beaumont, Texas
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Methanol mercaptan
Products and output:
Methionine
Chlorosulfonated polyethylene
Personnel: H. C. Bailey, manager
Remarks: New chlorosulfonated polyethlene unit scheduled for completion early in 1957.

E. I. DU PONT DE NEMOURS & CO., INC. 121
La Porte, Texas
Hydrocarbon raw materials:
Methanol
Products and output:
Methylamines
Dimethyl formamide
Carbomate fungicides
Personnel: T. T. Chase, manager

E. I. DU PONT DE NEMOURS & Co., INC. 122
Orange, Texas
Hydrocarbon raw materials:
Natural gas
Propane
Ethylene
Benzene
Cyclohexane
Products and output:
Nylon intermediates (adipic acid, hexamethylene diamine)
Methanol
Polyethylene—100,000,000 lb/yr
Personnel: D. B. Campbell, manager

E. I. DU PONT DE NEMOURS & CO., INC. 123
Victoria, Texas
Hydrocarbon raw materials:
Natural gas
Butadiene

Products and output:
Adiponitrile
Personnel: M. T. Shattuck, manager

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EASTERN STATES CHEMICAL CORP. 124
Houston, Texas
Approximate investment: $1,282,657
Gross value, products: 1955—$10,840,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Aromatics
Aliphatics
Total—2,000,000 bbl/yr
Personnel: H. M. Martin, manager; J. J. Carrigan, superintendent; E. S. Perkins, chief engineer

THOMAS A. EDISON Co. 125
Bloomfield, N. J.
Hydrocarbon raw materials:
Natural gas
Products and output:
Hydrogen
Remarks: Hydrogen is produced by a Girdler Corp. "Hygirtol" catalytic steam-reforming unit. Hydrogen is not sold but used as a raw material in iron purification.

EL PASO NATURAL GAS CO. 126
Farmington, N. M.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—12,600 ton/yr
Remarks: Company took over former plant of Imperial Sulphur and Acid Co. Sulfur operations shut down temporarily.

ESCAMBIA CHEMICAL CORP. 127
Pensacola, Fla.
Approximate investment: $30,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Acetylene
Anhydrous ammonia—91,250 ton/yr
Ammonium nitrate solutions—110,000 ton/yr
Ammonium nitrate prills—110,000 ton/yr
Nitric acid—80,000 ton/yr
Polyvinyl chloride—30,000,000 lb/yr
Personnel: R. U. Haslanger, president; D. J. Stark, vice president and production manager; J. G. Lavergne, chief design engineer; K. C. Roach, chief maint. eng.; J. M. Gafford, superintendent, polyvinyl plant; John Heckert, superintendent, nitrogen plant;
Remarks: Nitrogen products facilities in operation since Jan. 1956. Polyvinyl chloride unit to be completed in Dec. 1956.

ESSO STANDARD OIL CO. 128
Baton Rouge, La.
Hydrocarbon raw materials:
Natural gas
Petroleum gas and liquid fractions
Products and output:
Ethyl alcohol
Isopropyl alcohol
Iso-octyl alcohol
Decyl alcohol
Tridecyl alcohol
Ethyl ether
Isopropyl ether
Isobutylene
Tetrapropylene
Tripropylene
Butadiene
Isoprene-dicyclopentadiene
Benzene-petroleum resins
Aromatic tars
Butyl rubber—47,000 long ton/yr
Personnel: H. J. Voorhies, general manager
Remarks: New ethylene unit is under construction.

ESSO STANDARD OIL CO. 129
Linden, N. J.
Hydrocarbon raw materials:
Petroleum gases and liquid fractions
Products and output:
Isopropyl alcohol
Secondary butyl alcohol
Acetone
Methyl ethyl ketone
Isopropyl acetate
Secondary butyl acetate
Isobutylene
Polyisobutylene
Lube oil additives
Naphthenic acids
Personnel: G. R. Murrell, superintendent
Remarks: A new ethylene unit is scheduled for completion in 1957.

ETHYL CORP. 130
Joliet, Ill.
Products and output:
Anti-knock compounds
Remarks: Ethyl has taken options on land for possible plant near Joliet, Ill.

ETHYL CORP. 131
Baton Rouge, La.
Hydrocarbon raw materials:
Ethane
Ethylene
Propane
Benzene
Products and output:
Ethyl chloride
Ethylene di-bromide
Tetraethyl lead
Benzene hexachloride
Lindane
Personnel: R. M. Clothier, general manager
Remarks: Company received a fast write-off approval in May, 1955, for a $4,000,000 chemical "intermediates" plant.

ETHYL CORP. 132
Houston, Texas
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethyl chloride
Ethylene dichloride
Anti-knock compound
Personnel: G. O. Hayes, manager

ETHYL-DOW CHEMICAL CO. 133
Freeport, Texas
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylene dibromide
Personnel: V. A. Thorpe, plant manager

F

FIRESTONE PLASTICS CO. 134
Pottstown, Penna.
Hydrocarbon raw materials:
Petroleum base stocks
Products and output:
Polybutadiene-acrylonitrile type acyclic elastomers
Polybutadiene-styrene type acyclic elastomers
Personnel: W. D. Handley, manager

FIRESTONE TIRE & RUBBER CO.
(Synthetic Rubber and Latex Div.) 135
Lake Charles, La.
Approximate investment: $11,650,000
Gross value, products: 1955—$50,000,000 (est.) 1956—$73,000,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
S-type synthetic rubber
Personnel: W. H. Cain, manager; C. V. Dille, superintendent; C. R. McBride, plant engineer
Remarks: Expansion is underway to raise the present combined capacity of Akron and Lake Charles (190,000 ton/yr) to 230,000 ton/yr by Jan. 1, 1957.

FIRESTONE TIRE & RUBBER CO.
(Synthetic Rubber and Latex Div.) 136
Akron, Ohio
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
Synthetic rubber
Personnel: C. J. Weber, plant engineer
Remarks: For capacity, see Remarks under listing for Firestone's Lake Charles, La., plant.

FIRESTONE TIRE & RUBBER CO.
(Synthetic Rubber and Latex Div.) 137
Orange, Tex.
Hydrocarbon raw materials:
Butane
Benzene/ethylene
Products and output:
Butadiene—40,000 ton/yr
Styrene—75,000 ton/yr
Personnel: W. A. Wilson, manager
Remarks: Butadiene facilities under construction; completion date, early 1957. Styrene unit in engineering stage; completion date, early 1958.

FOSTER GRANT CO., INC. 138
Baton Rouge, La.
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Ethylene
Benzene
Products and output:
Styrene monomer—60,000,000 lb/yr
Personnel: F. D. Mayfield, manager

FREEPORT SULPHUR CO. 139
Westville, N. J.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulphur—12,775 ton/yr
Personnel: E. F. Fay, manager

G

GENERAL ANILINE & FILM CORP. 140
Linden, N. J.
Approximate investment: $8,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylene oxide—60,000,000 lb/yr
Ethylene glycol—35,000,000 lb/yr
Remarks: Scientific Design Co., Inc. has design and engrg. contract. Esso Std. Oil Co. will supply the ethylene. Completion date anticipated—1957.

GENERAL PETROLEUM CORP. 141
Torrance, California
Hydrocarbon raw materials:
Refinery wastes
Products and output:
Ammonium sulfate
Personnel: A. E. Thompson, manager
Remarks: Ammonium sulfate made only in small volume as a by-product of anti-air pollution facilities.

GENERAL TIRE & RUBBER CO. 142
Ashtabula, Ohio
Hydrocarbon raw materials:
Vinyl chloride
Products and output:
Polyvinyl chloride—24,000,000 lb/yr
Personnel: P. J. Wallace, manager

GENERAL TIRE & RUBBER CO. 143
Mogadore, Ohio
Hydrocarbon raw materials:
Styrene
Butadiene
Products and output:
Polyesters
Styrene resins
Vinylpyridine type acyclic elastomers
Rubber base paint latex
Personnel: J. A. Kleinhans, manager
Remarks: Expansion underway in styrene resin facilities.

GENERAL TIRE & RUBBER CO. 144
Odessa, Texas
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
S-type synthetic rubber—40,000 ton/yr
Remarks: In designing stages. Completion date expected, July 1, 1957.

GEORGIA-CAROLINA OIL CO. 145
Macon, Georgia
Personnel: R. W. Gober, manager; H. E. Chapman, superintendent; R. W. Jones, president
Remarks: Chemical plant affiliate: Triangle Chemical Co., Macon, Georgia, manufacturers of agricultural chemicals, wood preservers.

GLIDDEN CO. 146
Cleveland, Ohio
Remarks: Glidden has been licensed by Esso Research & Engineering Co. to conduct research on surface coatings from Standard's butoxy resin, a material derived from butadiene. Product now ready for commercial use at Esso Standard Oil, Baton Rouge, La., according to Glidden.

B. F. GOODRICH CHEMICAL CO. 147
Louisville, Ky.
Hydrocarbon raw materials:

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 133-140. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 300 petrochemicals

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Butadiene
Styrene
Acrylonitrile
Products and output:
Nitrile type synthetic rubber
Personnel: J. L. Nelson, manager
Remarks: A $2,500,000 expansion program was completed earlier this year.

B. F. GOODRICH CHEMICAL CO. 148
Akron, Ohio
Hydrocarbon raw materials:
Butadiene
Styrene
Acrylonitrile
Products and output:
Nitrile type synthetic rubber
Personnel: C. B. Cooper, manager

B. F. GOODRICH CHEMICAL CO. 149
Institute, W. Va.
Remarks: See Goodrich-Gulf Chemicals, Inc.

GOODRICH-GULF CHEMICALS, INC. 150
Northern Ohio
Approximate investment: $750,000
Products and output:
Synthetic rubber—4000 ton/yr

GOODRICH-GULF CHEMICALS, INC. 151
Orange, Texas
to date.
Remarks: Proposed plant site. No construction

GOODRICH-GULF CHEMICALS, INC. 152
Port Neches, Texas
Approximate investment: $13,000,000
Hydrocarbon raw materials:
Butadiene and styrene
Products and output:
"Ameripol" rubber (S-type)—90,000 ton/yr
Personnel: W. R. Bateman, plant manager; E. E. Mitchell, production manager; F. V. Morrision, plant engineer; B. C. Pryor, tech. manager.

GOODRICH-GULF CHEMICALS, INC. 153
Institute, W. Va.
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
Synthetic rubber—122,000 ton/yr
Personnel: F. C. Hands, manager; E. F. Barker, chief engineer; John Haas, production mgr.
Remarks: In partial operation since May, 1956

GOODYEAR SYNTHETIC RUBBER CORP. 154
Akron, Ohio
Approximate investment: $2,075,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
GR-S synthetic rubber—15,200 ton/yr
Personnel: R. C. Stell, manager
Remarks: Capacity expansion underway at both Akron and Houston, to cost total of $6-million. Completion scheduled for May 1957.

GOODYEAR SYNTHETIC RUBBER CORP. 155
Houston, Texas
Approximate investment: $11,889,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
GR-S rubber—137,500 ton/yr
Personnel: B. A. Rosinski, general manager
Remarks: Plant expansion to 170,000 ton/yr is now under way. A later project contemplated will bring capacity ultimately to 200,000 ton/yr.

GOODYEAR TIRE & RUBBER CO.
(Chemical division) 156
Akron, Ohio
Approximate investment: $5,250,000
Hydrocarbon raw materials:
Butadiene
Acrylonitrile
Styrene
Products and output:
Butadiene-acrylonitrile rubbers
High styrene resins
Personnel: J. W. Kosko, manager
Remarks: Spent $3.5-million since Nov. 1955, on new facilities, now finished.

W. R. GRACE & CO. 157
Baton Rouge, La.
Products and output:
Polyethylene—50,000,000 lb/yr
Remarks: Fluor Corp. has construction contract.

W. R. GRACE & CO. 158
Acton, Mass.
Approximate investment: $150,000
Hydrocarbon raw materials:
Butadiene and styrene
Products and output:
Co-polymers—4,000,000 lb/yr

GRACE CHEMICAL CO. 159
Woodstock, Tenn.
Approximate investment: $20,000,000
Gross value, products: 1955—$6,900,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—87,500 ton/yr
Personnel: J. G. Carriere, manager; C. Dougherty, superintendent; L. C. Skinner, chief engineer
Remarks: Grace Chemical is a subsidiary of W. R. Grace & Co. Plant was completed in late 1954.

GREAT SOUTHERN CHEMICAL CORP. 160
Corpus Christi, Texas
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Distillate gasoline
Butane
Products and output:
Benzene—160,000 bbl/yr
Toluene—12,500,000 gal/yr
Xylenes—100,000 bbl/yr
Butylenes—10,000,000 gal/yr
Personnel: L. K. Grove, superintendent

GRIFFIN CHEMICAL CO. 161
Richmond, Calif.
Remarks: see Napco Chemical Co.

GULF OIL CORP. 162
Philadelphia, Penna.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Propylene
Sulfur—50,000 ton/yr
Personnel: J. O. Timms, manager

GULF OIL CORP. 163
Crane County, Texas (Waddell Plant)
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—7,000 ton/yr
Personnel: John Sherman, manager

GULF OIL CORP. 164
Port Arthur, Texas
Hydrocarbon raw materials:
Refinery gases
Heptene
Products and output:
Ethylene—400,000,000 lb/yr
Sulfur—21,350 ton/yr
Isooctyl alcohol—9,000,000 lb/yr
Personnel: R. C. Faulkner, manager
Remarks: Sulfur capacity to be doubled in 1957.

H

HANCOCK CHEMICAL CO. 165
Long Beach, Calif.
Approximate investment: $2,000,000
Hydrocarbon raw materials:
Hydrogen sulfide
Products and output:
Sulfur
Personnel: W. T. Hancock, manager
Remarks: Operates on hydrogen sulfide from Hancock's own refinery.

HANCOCK CHEMICAL CO. 166
Wilmington, Calif.
Approximate investment: $3,500,000
Hydrocarbon raw materials:
Refinery hydrogen sulfide
Products and output:
Sulfur
Personnel: G. E. Smalley, manager
Remarks: Expansion recently completed. Raw gas comes from General Petroleum, Richfield, and The Texas Co.

HERCULES POWDER CO. 167
Hercules, Calif.
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—50,000 ton/yr
Personnel: E. St. P. Bellinger, manager

HERCULES POWDER CO. 168
Louisiana, Mo.
Approximate investment: $5,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—40,000 ton/yr
Pentaerythritol—24,000,000 lb/yr
Formaldehyde—100,000,000 lb/yr
Methanol—7,000,000 gal/yr
Personnel: J. B. Talley, manager
Remarks: Formaldehyde and pentaerythritol units, at cost of $6-million, are scheduled for completion late 1956. $2-million methanol unit under construction as part of pentaerythritol production

HERCULES POWDER CO. 169
Burlington, N. J.
Approximate investment: $4,500,000
Hydrocarbon raw materials:
Paraxylene
Products and output:
Dimethyl terephthalate—12,000,000 lb/yr
Personnel: D. A. Bunce, manager

HERCULES POWDER CO. 170
Gibbstown, N. J.
Hydrocarbon raw materials:
Benzene and propylene
Cumene
Products and output:
Cumene
Phenol—26,000,000 lb/yr
Acetone—16,000,000 lb/yr
Para-cresol—3,000,000 lb/yr
Cymene alcohol
Methylstyrene
Acetophenone
Personnel: L. W. Rothenberger, manager
Remarks: Company has started pilot scale manufacture of dicumyl peroxide, a cumene derivative

HERCULES POWDER CO. 171
Parlin, N. J.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Polyethylene—30,000,000 lb/yr
Personnel: E. F. Jennings, Jr., manager
Remarks: Under construction

HERESITE CHEMICAL CO. 172
Manitowoc, Wis.
Hydrocarbon raw materials:
Butadiene and styrene
Products and output:
Polybutadiene-acrylonitrile type acyclic elastomers
Personnel: I. L. Place, manager

HEYDEN CHEMICAL CORP. 173
Heyden Fords, N. J.
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Methanol (from natural gas)
Products and output:
Pentaerythritol—25,000,000 lb/yr
Remarks: Under construction. Completion scheduled for March, 1957.

HIDALGO CHEMICAL CO. 174
Brownsville, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Acetaldehyde
Propionaldehyde
Methanol
Ethanol
Iso-propanol
N-propanol
Iso-butanol
Acetone
Methyl propyl ketone
Methyl ethyl ketone
Methyl butyl ketone
Acetic acid
Propionic acid
Total chemicals—180,000,000 lb/yr
Personnel: L. L. Smith, superintendent
Remarks: Formerly Carthage Hydrocol Inc., but acquired by Stanolind Oil & Gas Co. in 1954. Hidalgo has signed exclusive contract with R. W. Greef & Co., Inc., for marketing the products. Operations were to begin early in 1956. Company also has fast tax write-off on $3,428,000 for process additions. Parent company is undergoing some organizational changes, the results of which may affect plans but which were not yet available at press time.

HOOKER ELECTROCHEMICAL CO. 175
Niagara Falls, N. Y.
Hydrocarbon raw materials:
Benzene
Toluene
Xylene
Pentane
Wax
Products and output:
Chlorbenzenes
Chlortoluenes and their derivatives
Hexachlorocyclopentadiene and chlorinated waxes
Personnel: F. L. Bryant, works manager; D. E. Springer, chief engineer; R. F. Schultz, production superintendent

Remarks: Durez Plastics and Chemicals, Inc., was consolidated into Hooker in April, 1955, and Niagara Alkali Co. was consolidated into Hooker in November, 1955.

J. M. HUBER CORP. 176
Borger, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks
Furnace blacks
Personnel: H. S. Barbour, general manager; J. L. Spair, channel plant superintendent; L. V. Moxom, furnace plant superintendent; J. D. McGregor, chief engineer
Remarks: A 20-30 million lb/yr furnace black plant being erected will add 15% to company's furnace black capacity.

J. M. HUBER CORP. 177
Eldon, Texas
Hydrocarbon raw materials:
Oil
Products and output:
Carbon black
Personnel: M. D. Nuttall, manager; J. B. Stewart, superintendent; Paul Post, chief engineer

HUMBLE OIL & REFINING CO. 178
Baytown, Texas
Approximate investment: $45,113,700
Gross value, products: 1955—$59,284,200
(est.) 1956—$68,674,100
Hydrocarbon raw materials:
Refinery gases
Petroleum fractions
Products and output:
Cyclohexane
Butylene concentrate
Toluene
Xylene
Paraxylene
Aromatic solvents
Aliphatic solvents
Tetrapropylene
Tripropylene
Carbon black oil feed stock
Butadiene—49,000 short ton/yr
Butyl rubber—44,500 long ton/yr
Personnel: G. L. Farried, plants manager; James Harrop, general superintendent; E. F. Voss, chief engineer
Remarks: Butadiene expansion to 65,000 ton/yr will be completed in 1957.

I & J

IMPERIAL SULPHUR AND ACID CO. 179
Farmington, N. M.
Remarks: See El Paso Natural Gas Co.

INDEX CHEMICALS CO. 180
Houston, Texas
Hydrocarbon raw materials:
Butane and sulfur
Products and output:
Thiophene
Methyl, ethyl and octyl mercaptons
Dimethyl and diethyl sulfides
Remarks: Sharples Chemical Division, Pennsylvania Salt Mfg. Co., has licensing agreement with Socony Mobil Oil Co. to manufacture and sell thiophene under Socony patents. Plant at Houston is operated by Index Chemicals Co., a subsidiary of Penn-Salt.

JEFFERSON CHEMICAL CO. 181
Port Neches, Texas
Hydrocarbon raw materials:
Refinery gases
Products and output:
Ethylene glycol
Diethylene glycol
Ethylene oxide
Ethylene dichloride
Mono-, di-, tri-ethanolamine
Nonyl phenol
Aromatic distillate
Morpholine
Personnel: L. R. Strawn, manager; R. H. Darling, chief engineer
Remarks: Owned jointly by American Cyanamid Co. and The Texas Co.

JEFFERSON LAKE SULPHUR CO. 182
Manderson, Wyo.
Approximate investment: $700,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—50,000 long ton/yr
Personnel: C. H. Lewis, general manager; James Leeper, superintendent
Remarks: Operating at about 50% of capacity because of shortage of acid gas supplies.

K & L

M. W. KELLOGG CO. 183
Houston, Texas
Remarks: Company has purchased land on the Houston Ship Channel but has made no definite commitment on use. One facility under consideration is polyethylene.

KENDALL REFINING CO. 184
Bradford, Penna.
Catalytic reformer, not operated for petrochemicals.

KOPPERS CO., THE 185
Wilmington, Calif.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Natural gas
Ethylene
Products and output:
Ethylene
Polyethylene—30,000,000 lb/yr
Remarks: Polyethylene facilities to be joint venture with Brea Chemicals, Inc. Koppers to build poly units; Brea will operate. Gas to come from Union Oil Co.'s Los Angeles refinery. Completion, mid-1957.

KOPPERS CO., INC. 186
Woodbridge, N. J.
Hydrocarbon raw materials:
Ethylene
Products and output:
Polyethylene—30,000,000 lb/yr
Remarks: New plant, under construction. Completion date mid-1957. Ethylene to come from Esso's new unit being built at Linden.

KOPPERS CO., INC. 187
Monaca, Penna. (Kabuta Plant)
Approximate investment: $25,000,000
Gross value, products: 1955—$38,000,000
(est.) 1956—$40,000,000
Hydrocarbon raw materials:
Benzene and ethylene
Butadiene
Products and output:
Styrene monomer—50,000 ton/yr
Polystyrene—25,000 ton/yr
Divinyl benzene
Personnel: F. R. Garner, manager; R. Johnson, chief engineer; M. R. Dawson & L. Wilkins, assistant managers

KOPPERS CO., INC. (Chemical Division) 188
Oil City, Penna.
Approximate investment: $2,000,000
Gross value, products: 1955—$3,000,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alkylated cresols—2,400,000 lb/yr
Personnel: C. L. Mehring, general manager
Remarks: Expansion under way will add 3,600,000 lb/yr of capacity.

KOPPERS CO., INC. (Chemical Division) 189
Port Arthur, Tex. (Williams Plant)
Approximate investment: $19,000,000
Gross value, products: 1955—$10,000,000
(est.) 1956—$13,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylbenzene—120,000,000 lb/yr
Polyethylene—18,000,000 lb/yr
Personnel: H. E. Roche, general manager; D. B. Stewart, assistant manager

LION OIL CO.
(Div. of Monsanto Chemical Co.) 190
El Dorado, Ark.
Approximate investment: $40,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—213,000 ton/yr
Ammonium sulfate—133,000 ton/yr
Ammonium nitrate—155,500 ton/yr
Fertilizer solutions —120,000 ton/yr
Nitric acid—165,000 ton/yr

Who Makes What Petrochemicals

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. . . plus descriptions of 300 petrochemicals

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Sulfuric acid—112,000 ton/yr
Personnel: A. M. Sprague; G. D. Rucker, assistant manager
Remarks: Lion was merged with Monsanto as of Sept. 30, 1955. Output figures shown above for all but ammonia vary with market demand.

LION OIL CO.
(Div. of Monsanto Chemical Co.) 191
Luling, La. (Barton plant)
Approximate investment: $31,000,000
Hydrocarbon raw materials:
Natural gas
Waste gases
Products and output:
Anhydrous ammonia—140,000 ton/yr
Ammonium nitrate—36,500 ton/yr
Dry ice and liquid CO_2—15,330 ton/yr
Nitric acid—155,000 ton/yr
Personnel: R. L. Van Zandt, manager; S. B. Johnson, assistant manager.
Remarks: An adipic acid unit is being built at cost of "several million dollars" with completion set for early 1957. Output figures shown for ammonium nitrate and nitric acid vary with market demand.

LUBRIZOL CORP. 192
Cleveland, Ohio
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Personnel: C. G. O'Bannon, production manager

LUBRIZOL CORP. 193
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Personnel: K. A. Danskin, manager

LYNN CARBON BLACK CO. 194
San Angelo, Texas
Approximate investment: $175,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon black—12,000,000 lbs/yr
Personnel: W. H. Balka, engineering consultant
Remarks: Engineering pilot plant was scheduled for completion in spring of 1956.

M

MAGNOLIA PETROLEUM CO. 195
Beaumont, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Cresylic acid
Sodium cresylate solutions
Personnel: J. W. Newton, vice president and general manager; C. M. Fabian, superintendent; G. C. Debney, chief engineer

MARBON CHEMICAL DIV.—BORG-WARNER CORP. 196
Gary, Indiana
Hydrocarbon raw materials:
Acrylonitrile
Butadiene
Styrene
Products and output:
High styrene resins for rubber and paint
Rubber-to-metal adhesives
ABS "Hi Impact" resins
Personnel: Robert Shattuck, manager; J. F. Showalter, superintendent; C. L. Taylor, chief engineer.

MARBON CHEMICAL DIVISION—BORG-WARNER CORP. 197
Washington, W. Va.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Acrylonitrile
Butadiene
Styrene
Products and output:
ABS "Hi Impact" resins
Personnel: Robert Shattuck, manager; Bryon Bailey, superintendent; Carl Taylor, chief engineer
Remarks: $10-million contract for construction awarded to Catalytic Construction Co. The first construction will fence in only 65 acres of a larger site. Completion scheduled for early 1957.

THE MERICHEM CO. 198
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:

Cresylic acid
Phenol-cresol blends
Sodium sulfide
Sodium sulfhydrate
Personnel: J. T. Rues, vice president; L. L. Jolly, superintendent; J. D. Ligon, chief engineer.

MISSISSIPPI CHEMICAL CORP. 199
Yazoo City, Miss.
Approximate investment: $18,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—95,000 ton/yr
Ammonium nitrate—140,000 ton/yr
Personnel: W. B. Dunwoody, general operations manager

MISSISSIPPI RIVER CHEMICAL CO. 200
(Div. of Mississippi River Fuel Corp.)
Selma, Mississippi
Approximate investment: $15,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—72,000 ton/yr
Nitric acid—79,200 ton/yr
Ammonium nitrate—100,800 ton/yr
Personnel: C. H. Lashlee, plant manager

MOBAY CHEMICAL CO. 201
New Martinsville, W. Va.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Toluene diamine
Adipic acid
Ethylene glycol
Products and output:
Isocyanates
Polyesters
Butylene glycol
Phthalic anhydride
Personnel: D. J. Miller, plant manager; R. F. Cassidy, production superintendent
Remarks: Company is owned jointly by Monsanto Chemical Co. and Farbenfabriken Bayer A. G. of Germany. Isocyanates and polyesters capacities are being tripled. Blaw-Knox holds construction contract.

MONSANTO CHEMICAL CO. 202
Avon, Calif.
Approximate investment: $5,000,000
Hydrocarbon raw materials:
Refinery gases
Acid sludge
Products and output:
Phenol—20,000,000 lb/yr
Sulfuric acid—80,000 ton/yr
Personnel: Dominic Donna, manager
Remarks: Acid operation is jointly with Tidewater Oil Co. Sulfur is also used as part of feed, besides acid sludge and sour gas.

MONSANTO CHEMICAL CO. 203
Texas City, Texas
Approximate investment: $15,300,000
(for vinyl chloride and methanol only)
Hydrocarbon raw materials:
Benzene
Ethylene
Methane
Propane
Natural gas
Products and output:
Hydrogen cyanide
Styrene monomer—140,000 ton/yr
Vinyl chloride
Acrylonitrile
Polyethylene—66,000,000 lb/yr
Methanol—25,000,000 gal/yr
Personnel: J. S. Putnam, plant manager; H. K. Eckert, director of manufacturing
Remarks: Methanol unit operated by Monsanto and Heyden Chemical Corp. Polyethylene capacity is scheduled for 50% increase by 1957. Company has certificate of necessity for $16,800,000 nitrogen products plant.

MONSANTO CHEMICAL CO. 204
(Lion Oil Co. Division)
(See Lion Oil Co.)

MONTANA SULFUR AND CHEMICAL CO. 205
Billings, Mont.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfur
Remarks: Announced in Jan., 1956. Plant is to use gas from Carter Oil Co. and Continental Oil Co. refineries at Billings, Mont.

MONTROSE CHEMICAL CO. 206
Newark, N. J.
Hydrocarbon raw materials:
Cresylic acid
Products and output:
Tricresyl phosphate
Personnel: Benjamin Rothberg, vice president

MORTON-WITHERS CHEMICAL CO. 207
Greensboro, N. C.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Sulfonates
Synthetic lubes
Lube oil additives
Total—20,000,000 lb/yr
Personnel: R. T. Masters, superintendent

N

NATIONAL FARMERS RESOURCES, INC. 208
Sanpete County, Utah
Approximate investment: $12,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—45,000 ton/yr
Remarks: In planning stage only. Anticipated completion "some time in 1957."

NATIONAL PETRO-CHEMICALS CO. 209
Tuscola, Ill.
Approximate investment: $70,000,000
Gross value, products: 1955—$26,000,000
(est.) 1956—$35,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ethyl alcohol—40,000,000 gal/yr
Ethyl chloride—60,000,000 lb/yr
Polyethylene—50,000,000 lb/yr
Ether—4,500,000 gal/yr
Personnel: J. W. Nixon, manager; G. A. Siegelman, asst. plant manager; C. D. Carnes, chief engr.
Remarks: Expanding hydrocarbon recovery, ethylene, polyethylene, and power plant.

NATURAL GAS ODORIZING CO. 210
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Methyl mercaptan
Ethyl mercaptan
Personnel: C. E. Gill, president

NECHES BUTANE PRODUCTS CO. 211
Port Neches, Texas
Approximate investment: $38,600,000
Hydrocarbon raw materials:
Butylene
Butadiene
Products and output:
Butadiene—95,000 short ton/yr
Synthetic rubbers—112,000 long ton/yr
Personnel: T. A. McCoy, manager; J. J. Koch, superintendent; W. P. Kelly, chief engineer
Remarks: Owned 50-50 by Texas-U. S. Chemical Co. and Goodrich-Gulf Chemical Co.

NEVILLE CHEMICAL CO. 212
Anaheim, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Hydrocarbon resins
Aromatic solvents
Personnel: R. L. Ulrich, manager

NEVILLE CHEMICAL CO. 213
Neville Island (Pittsburgh), Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Hydrocarbon resins
Aromatic solvents
Personnel: H. J. Shearer, superintendent

NEWPORT INDUSTRIES, INC. 214
Pensacola, Fla.
Hydrocarbon raw materials:
Natural gas
Products and output:
Hydrogen
Personnel: H. L. Morter, manager; R. E. Cole, chief engineer
Remarks: Hydrogen produced by catalytic steam-reforming unit.

NINOL LABORATORIES 215
Chicago, Ill.
Approximate investment: $750,000
Hydrocarbon raw materials:
Alkylated benzene
Products and output:
Special sulfonates—15,000,000 lb/yr
Personnel: Jerome Kritchevsky, president

NOPCO CHEMICAL CO. 216
Richmond, Calif.
Hydrocarbon raw materials:
Crude petroleum sulfonates
Naphthenates
Products and output:
Naphthenic acid
Lube oil additives
Polyvinyl acetate emulsions
Plasticizers
Personnel: J. E. Connelly, manager
Remarks: Formerly Griffin Chemical Co.

NORTHERN CHEMICAL INDUSTRIES, INC. 217
Searsport, Maine
Approximate investment: $14,000,000
Hydrocarbon raw materials:
Bunker C fuel Oil
Products and output:
Anhydrous ammonia—45,000 ton/yr
Nitric acid—21,600 ton/yr
Mixed fertilizer—50,000 ton/yr
Sulfuric acid—70,000 ton/yr
Personnel: F. L. Litty, manager; Geo. Odom, superintendent
Remarks: Scheduled for completion August, 1956.

NUODEX PRODUCTS CO., INC. 218
Long Beach, Calif.
Hydrocarbon raw materials:
Petroleum derivatives
Products and output:
Naphthenates
Fungicides
Bactericides
Additives
Personnel: A. J. Roubo, manager

NUODEX PRODUCTS CO., INC. 219
Elizabeth, N. J.
Hydrocarbon raw materials:
Petroleum derivatives
Products and output:
Naphthenates
Fungicides
Bactericides
Additives
Personnel: J. F. Kilcullen, manager

NUODEX PRODUCTS CO., INC. 220
Newark, N. J.
Hydrocarbon raw materials:
Petroleum derivatives
Products and output:
Naphthenates
Fungicides
Bactericides
Additives
Personnel: R. A. Allen, manager

O

ODESSA BUTADIENE CO. 221
Odessa, Texas
Approximate investment: $22,000,000
Hydrocarbon raw materials:
Butene
Products and output:
Butadiene—50,000 ton/yr
Remarks: Fluor Corp., Ltd., has contract for design, engineering, and construction. El Paso Natural Gas Co. is parent firm. Scheduled for completion July 1, 1957.

OLIN MATHIESON CHEMICAL CORP. 222
Magnolia, Ark.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur
Personnel: O. W. Taylor, manager

OLIN MATHIESON CHEMICAL CORP. 223
McKamie, Ark.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur
Personnel: O. W. Taylor, manager

OLIN MATHIESON CHEMICAL CORP. 224
Brandenburg, Ky.
Hydrocarbon raw materials:
Ethane (from natural gas)
Products and output:
Ethylene oxide
Ethylene glycol
Diethylene glycol
Ethylene dichloride
Triethylene glycol
Polyglycols
Glycol ethers
Ethanolamines
Dichloroethyl ether
Ethylene diamine
Polyamines
Personnel: C. J. Thomas, manager; C. C. Hale, manager of engineering

OLIN MATHIESON CHEMICAL CORP. 225
Lake Charles, La.
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—95,000 ton/yr
Nitric acid
Sodium nitrate
Hydrazine
Personnel: C. C. Hightower, manager; W. C. Moseley, assistant manager; A. D. Hargroder, chief engineer.

ORONITE CHEMICAL CO. 226
Oak Point, La.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Personnel: T. I. Clausen, manager
Remarks: Subsidiary of Standard Oil Co. of Calif. Capacity at Oak Point plant is reported to be sufficient to treat 20,000 b/d of lubricants.

OXFORD ENGINEERING CO. 227
Fullerton, Calif.
Personnel: H. G. Henderson, manager

P & Q

PAN AMERICAN REFINING CORP. 228
(See American Oil Co.)

PAN-AM SOUTHERN CORP. 229
El Dorado, Ark.
Hydrocarbon raw materials:
Propane-propylene
Butane-butylene
Products and output:
Propylene tetramer—3,800,000 gal/yr
Polybutylene—2,000,000 gal/yr
Trimer—350,000 gal/yr
Personnel: E. N. Kimes, manager; J. M. Brown assistant manager; C. L. Parris, chief engineer
Remarks: Company name now is Pan-American Chemicals Corp, but parent firm, Standard Oil Co. (Indiana) is undergoing organizational changes, results of which were not yet available at press time.

PATHFINDER CHEMICAL CO. 230
Niagara Falls, N. Y.
Hydrocarbon raw materials:
Acetylene
Products and output:
Polyvinyl chloride resins
Vinyl chloride copolymer dispersion resin
Vinyl chloride copolymer latex
Personnel: F. H. Manchester, manager; R. H. Evans, chief engineer
Remarks: Pathfinder is a subsidiary of Good-Year Tire & Rubber Co., Chemical Division. The company has invested $500,000 in new facilities since Nov., 1955.

PENNSYLVANIA INDUSTRIAL CHEMICAL CORP. 231
Chester, Penna.
Hydrocarbon raw materials:
Crude oil
Products and output:
Butadiene
Naphthalene
Ethylbenzene
Benzene
Ethylene
Isoprene
Dicyclopentadiene
Piperylene
Isopropyl benzene
Personnel: B. F. Schweim, manager; J. D. Vermeychuk, superintendent
Remarks: This is a small, 40,000 gal/day plant, used as a pilot unit, but with some commercial production.

PENNSYLVANIA INDUSTRIAL CHEMICAL CORP. 232
Clairton, Penna. (West Elizabeth)
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Styrene
Petroleum resins
Personnel: R. A. Taylor, manager
Remarks: West Elizabeth operates on variety of materials, petroleum and coal-tar derivatives, and acts as "feeder" to main plant at Clairton, where all raw materials are coal-tar at present.

PENNSYLVANIA REFINING CO. 233
Karns City, Penna.
Approximate investment: $500,000
Gross value, products: 1955—$690,000
(est.) 1956—$750,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Petroleum sulfonate—5,000,000 lb/yr
Personnel: John Beck, manager; C. M. McCullough, superintendent

PENNSYLVANIA SALT MANUFACTURING CO. (Industrial Div.) 234
Riverview, Michigan
Hydrocarbon raw materials:
Pentane
Tri-isobutylene
Products and output:
Amyl alcohol
Amyl chloride
Amyl acetate
Amyl phenols
Amyl naphthalenes
Tert-dodecylmercaptan
Personnel: H. F. Bjork, area manager; R. P. Ogden, production manager; J. W. Mayers, chief engineer
Remarks: Plant location formerly listed as Wyandotte, Mich.

PETROCHEMICALS, INC. 235
Irving, Texas
Approximate investment: $1,000,000
Hydrocarbon raw materials:
Crude oil
Products and output:
Partial aromatic solvents—1500 b/d
Personnel: Joseph Shaaf, superintendent

PETROCHEMICALS CO. 236
(See Universal Detergents, Inc.)

PETROLEUM CHEMICALS, INC. 237
Lake Charles, La.
Approximate investment: $17,500,000
Gross value, products: 1955—$18,000,000
(est.) 1956—$24,000,000
Hydrocarbon raw materials:
Refinery gases
Products and output:
Butadiene—63,000 ton/yr
Personnel: J. H. Olehy, operating manager; J. O. Hartman, superintendent; F. M. Simpson, vice president
Remarks: Fluor Corp. has construction contract for $4,350,000 expansion in butadiene capacity to 79,000 ton/yr. A 100,000 ton/yr anhydrous ammonia plant, $12,500,000 investment, is cheduled for completion in fall of 1957. A 200,000,000 lb/yr (or over) ethylene plant is scheduled for completion late in 1957.

PETRO-TEX CHEMICAL CORP. 238
Houston, Tex.
Approximate investment: $24,197,000
Hydrocarbon raw materials:
Butane
Butylene
Products and output:
Butadiene—90,000 ton/yr
Personnel: J. O'C. Brown, manager; D. V. Fitz, superintendent; L. L. Hess, plant engr. and maint. supt.
Remarks: Petro-Tex is jointly and equally owned by Tennessee Gas Transmission Co. and Food Machinery & Chemical Corp. A current expansion program, scheduled for completion about Jan. 1, 1957, is designed to raise the plant's butadiene output by approximately 50%.

PHILLIPS PACIFIC CHEMICAL CO. 239
Kennewick, Washington
Approximate investment: $15,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—73,000 ton/yr
Personnel: W. D. Payton, superintendent
Remarks: New company, owned jointly by Phillips Petroleum Company, and Pacific Northwest Pipeline Corporation. Plant scheduled for completion late this year.

PHILLIPS CHEMICAL CO. 240
Andrews County, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur
Remarks: Plant is in planning stage only. No definite completion date.

PHILLIPS CHEMICAL CO. 241
Big Spring, Texas
Hydrocarbon raw materials:
Mixed xylenes
Products and output:
Paraxylene—3,285,000 lbs/yr
Personnel: A. F. Legatski, superintendent

PHILLIPS CHEMICAL CO. 242
Borger, Texas
Hydrocarbon raw materials:
Liquid fractions
Products and output:
Furnace blacks—290,000,000 lb/yr
Personnel: H. E. Haltom, superintendent

PHILLIPS CHEMICAL CO. 243
Borger, Texas
Hydrocarbon raw materials:
Butane
Styrene & Butadiene
Products and output:
Butadiene—88,000 short ton/yr
GR-S rubber—78,000 long ton/yr
Personnel: G. H. Short, superintendent
Remarks: Expansion in GR-S to 78,000 long ton/yr is under way, followed by further expansion, to an ultimate 108,000 long ton/yr by mid-1957. Corresponding expansion to 112,000 short ton/yr is taking place in butadiene facilities with completion also in mid-1957.

PHILLIPS CHEMICAL CO. 244
Crane County, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—31,000 long ton/yr
Personnel: A. F. Legatski, superintendent

PHILLIPS CHEMICAL CO. 245
Etter, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—191,600 ton/yr
Ammonium nitrate—142,000 ton/yr
Nitrogen solutions—55,000 ton/yr
Nitric acid—130,000 ton/yr
Personnel: C. W. Forman, superintendent

PHILLIPS CHEMICAL CO. 246
Goldsmith, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—36,500 long ton/yr
Personnel: A. F. Legatski, superintendent

PHILLIPS CHEMICAL CO. 247
Pasadena, Texas
Hydrocarbon raw materials:
Ethylene
Natural gas
Products and output:
Polyethylene—110,000,000 lb/yr
Ammonia—191,600 ton/yr
Ammonium sulfate—365,000 ton/yr
Methylvinylpyridine—3,000,000 lb/yr
Ammonium phosphate—147,800 ton/year
Personnel: R. G. Rhodes, superintendent
Remarks: The polyethylene plant located at Adams Terminal is now under construction and scheduled for completion in 1958.

PHILLIPS CHEMICAL CO. 248
Sweeny, Texas
Hydrocarbon raw materials:
Butane and/or propane
Products and output:
Ethylene—180,000,000 lb/yr
Personnel: G. A. Ibach, superintendent
Remarks: Under construction. Completion scheduled for second quarter of 1957.

PHILLIPS CHEMICAL CO. 249
Somewhere on Gulf Coast
Hydrocarbon raw materials:
Oil
Products and output:
Carbon black—64,000,000 lb/yr
Remarks: In planning stage only. No definite completion date nor site selected.

PITT-CONSOL CHEMICAL CO. 250
Newark, N. J.
Approximate investment: $3,500,000
Hydrocarbon raw materials:
Refinery fractions, mainly spent caustics
Products and output:
Cresols
Cresylic acid
Pheols
Resins
Personnel: R. H. Martin, manager; R. L. Com-

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 133-140. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 300 petrochemicals

In addition to the Index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

stock, superintendent; E. T. Rudy, chief engineer
Remarks: Formerly Reilly Tar & Chemical Co. plant, bought by Pitt-Consol in September, 1955. Some revamping and modernization scheduled for completion this fall.

PRODUCTOL CO. 251
Santa Fe Springs, Calif.
Hydrocarbon raw materials:
Petroleum and coal tar fractions
Products and output:
Phenol
Cresols
Cresylic acids
Naphthalene
Personnel: E. E. Chipman, manager; J. W. Burrok, superintendent

PURE OIL CO. 252
Lemont, Ill.
Approximate investment: $300,000
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfur—5,250 ton/yr
Personnel: J. M. Lawson, manager

PURE OIL CO. 253
Toledo, Ohio
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Toluene
Xylene
Aromatic fractions
Personnel: H. H. Dronberger, manager
Remarks: Aromatic products all going into motor fuel at present.

PURE OIL CO. 254
Nederland, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Solvents
Personnel: C. W. Cooper, manager; I. L. Hostetler, general superintendent

PUREX CORP. 255
South Gate, Calif.
Hydrocarbon raw materials:
Propylene
Products and output:
Sulfonated alkyl benzene
Personnel: S. M. Dahl, production manager

PUREX CORP. 256
St. Louis, Mo.
Hydrocarbon raw materials:
Propylene
Products and output:
Sulfonated alkyl benzene
Personnel: B. Rich, manager

QUAKER CHEMICAL PRODUCTS CORP. 257
Conshohocken, Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Detergents
Metal cleaners
Textile finishing compounds
Corrosion preventives
Personnel: Wm. J. Gavin, manager

R

REICHHOLD CHEMICALS CO. 258
Tuscaloosa, Ala.
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Methanol
Petroleum fractions
Benzene
Products and output:
Pentaerythritol—5,000,000 lb/yr
Formaldehyde—30,000,000 lb/yr
Synthetic resins
Phenol
Personnel: W. O. Fetterly, plant manager; B. F. Galloway, superintendent

REICHHOLD CHEMICALS CO. 259
Azusa, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic resins
Phthalic anhydride—10,000,000 lb/yr
Personnel: J. H. Zeller, manager; J. E. Jared, superintendent

REICHHOLD CHEMICALS CO. 260
San Francisco, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic resins
Personnel: M. W. Reece, general manager; S. W. Small, plant manager; C. A. Koski, superintendent

REICHHOLD CHEMICALS CO. 261
Jacksonville, Fla.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic resins
Personnel: R. B. Fellows, manager

REICHHOLD CHEMICALS CO. 262
Ballardvale, Mass.
Hydrocarbon raw materials:
Petroleum fractions
Methanol
Products and output:
Synthetic resins
Formaldehyde
Personnel: R. T. Urich, general manager; H. F. Shepard, plant manager
Remarks: Resin unit expansion was completed early in 1956.

REICHHOLD CHEMICALS CO. 263
Detroit, Mich.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic resins
Phthalic anhydride—8,000,000 lb/yr
Personnel: C. J. Windsor, manager; J. W. Milford, superintendent
Remarks: Expansion under way is scheduled for completion early in 1957.

REICHHOLD CHEMICALS CO. 264
Elizabeth, N. J.
Hydrocarbon raw materials:
Petroleum fractions
Benzene
Products and output:
Synthetic resins
Maleic anhydride—2,000,000 lb/yr
Personnel: J. E. d'Angelo, manager; C. G. Matko, chief engineer
Remarks: Maleic anhydride expansion recently completed. Company has plans for $10-million in expansion throughout all plants, including following product capacity expansions: phenol, pentaerythritol, phthalic anhydride, maleic anhydride, formaldehyde, glycerine.

REICHHOLD CHEMICALS CO. 265
Charlotte, N. C.
Hydrocarbon raw materials:
Petroleum fractions
Methanol
Products and output:
Synthetic resins
Formaldehyde
Personnel: G. D. Hanner, superintendent

REICHHOLD CHEMICALS CO. 266
Seattle, Wash.
Hydrocarbon raw materials:
Petroleum fractions
Methanol
Products and output:
Synthetic resins
Formaldehyde
Pentachlorophenol—360,000 lb/yr
Personnel: H. O. Warner, plant manager; C. E. Ruiga, chief engineer

REICHHOLD CHEMICALS CO. 267
Tacoma, Wash.
Hydrocarbon raw materials:
Benzene
Products and output:
Phenolic resins
Pentachlorophenol—4,000,000 lb/yr
Plywood glues—24,000,000 lb/yr
Personnel: H. O. Warner, plant manager; Richard Rose, superintendent; C. E. Ruiga, chief engineer
Remarks: New plant, onstream since April, 1956. A new formaldehyde unit now being added, with completion expected early in 1957.

REILLY TAR & CHEMICAL CO. 268
Newark, N. J.
See Pitt-Consol Chemical Co.

REPUBLIC OIL REFINING CO. 269
Texas City, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Propylene tetramer—16,500,000 lb/yr
Propylene trimer—24,400,000 lb/yr
Personnel: L. W. Robbie, manager; M. E. Houser, superintendent; H. Howell, chief engineer

RICHFIELD OIL CORP. 270
Los Angeles, Calif.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Ethylene—25,000,000 lb
Sulfur—23,725 ton/yr
H_2S—56,000,000 lb
Personnel: C. R. McKay, manager
Remarks: Company plans to spend $500,000 to increase capacity of sulfur recovery.

RICHFIELD OIL CORP. 271
Watson, California
Hydrocarbon raw materials:
Refinery gases
Products and output:
Hydrogen sulfide—56,000,000 lb/yr
Ethylene—25,000,000 lb/yr
Personnel: C. R. McKay, manager; R. P. Corlew, assistant manager

ROHM & HASS CO. 272
Deer Park, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Hydrogen cyanide
Acetone cyanhydrin
Acrylic chemicals
Higher alcohols
Personnel: V. C. Henrich, manager; D. W. Kenny, asst. to mgr; R. Ayres, chief engineer
Remarks: Company is planning a new $10,000,000 unit to make acetylene from natural gas, with capacity of about 20,000,000 lb/yr.

ROOSEVELT OIL & REFINING CO. 273
Mt. Pleasant, Mich.
Approximate investment: $2,000,000
Gross value, products: 1955—$2,150,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene—3,000,000 gal/yr
Toluene—2,400,000 gal/yr
Aliphatic naphthas—18,000,000 gal/yr
Personnel: E. A. Morrow, manager; Tom Williams, superintendent; Brice Weber, chief engineer

S

ST. PAUL AMMONIA PRODUCTS, INC. 274
Pine Bend, Minn.
Approximate investment: $15,000,000
Hydrocarbon raw materials:
Natural gas & residual oil
Products and output:
Ammonia—70,000 ton/yr
Nitrogen solutions
Personnel: Frank W. Wilson, general manager
Remarks: Output of plant will be sold to Central Farmers Fertilizer Co. Plant is scheduled for completion end of 1956.

SAN JACINTO CHEMICAL CO. 275
Houston, Texas
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—43,200 ton/yr
Personnel: D. A. White, manager
Remarks: Company is a division of Smith-Douglas Co., Norfolk, Va.

SEABOARD OIL CO. 276
Powell, Wyo.
Approximate investment: $1,000,000
Gross value, products: 1955—$978,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—15,750 ton/yr
Personnel: John A. Tiehen, superintendent; W. R. Strong, foreman

SHAMROCK OIL AND GAS CORP. 277
Sunray, Texas
Approximate investment: $285,000
Gross value, products: 1955—$349,000
(est.) 1956—$275,000
Hydrocarbon raw materials:
Acid gases
Products and output:
Sulfur—10,800 ton/yr
Personnel: A. V. Beckworth, superintendent; C. D. Van Vliet, chief engineer

SHARPLES CHEMICAL DIVISION (Pennsylvania Salt Mfg. Co.) 278
Wyandotte, Mich.
Hydrocarbon raw materials:

Pentane
Tri-isobutylene
Products and output:
Amyl alcohol
Amyl chloride
Amyl acetate
Amyl phenols
Amyl naphalenes
Amyl mercaptan
Tert-dodecylmercaptan
Tert-dodecylether
Polyethylene glycol
Personnel: H. F. Bjork, manager; R. P. Ogden production manager; J. W. Mayers, chief engineer
Remarks: No longer a corporate entity. Sharples is now part of Pennsalt's Industrial Div. (See Pennsylvania Salt Mfg. Co.)

SHELL CHEMICAL CORP. 280
Dominguez, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alcohols
Solvents
Other organic chemicals
Personnel: O. M. Williams, manager

SHELL CHEMICAL CORP. 281
Gardena, Calif.
Remarks: Now considered a part of Torrance, Calif., operations.

SHELL CHEMICAL CORP. 282
Martinez, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alcohol
Solvents
Other organic chemicals
Para-tertiary-butyl benzoic acid
Lube oil additives
Personnel: E. W. Casagrande, manager

SHELL CHEMICAL CORP. 283
Pittsburg, Calif.
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia
Ammonium sulfate
Carbon black
Personnel: E. S. Bodine, manager

SHELL CHEMICAL CORP. 284
Torrance, Calif.
Approximate investment: $30,000,000
Hydrocarbon raw materials:
Butylenes
Benzene
Propane
Products and output:
Butadiene—48,000 ton/yr
Styrene—62,500 ton/yr
GR-S rubber—89,000 ton/yr
Personnel: M. Voogd, manager
Remarks: Cost and capacities are those reported at time of purchase of this plant from government, spring, 1955.

SHELL CHEMICAL CORP. 285
Ventura, Calif.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—65,000 ton/yr
Urea—36,000 ton/yr
Personnel: F. D. Kuenzly, manager
Remarks: Urea facilities scheduled for completion in Sept., 1956. Investment and capacity figures are those last reported publicly. Company neither comfirms nor denies them, but states they are no longer current.

SHELL CHEMICAL CORP. 286
Denver, Colo.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Aldrin
Dieldrin
Endrin
Soil fumigant
Specialty chemicals
Personnel: J. G. Bejarano, manager

SHELL CHEMICAL CORP. 287
Norco, La.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Crude chlorohydrins
Allyl chloride, D-D
Hydrogen peroxide
Acrolein
Glycerine—30,000,000 lb/yr
Personnel: F. E. Caddy manager
Remarks: Peroxide unit is under construction. A 40,000,000 lb/yr methyl ethyl ketone unit is under construction, due for completion early in 1957.

SHELL CHEMICAL CORP. 288
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alcohols—20,000,000 gal/yr
Solvents
Epon resins
Glycerine
Bis-phenol A
Personnel: Glenn Purcell, manager
Remarks: Capacity figure for alcohol is no longer correct, but company prefers not to report what the change might be.

SHELL OIL CO. 289
Martinez, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Petroleum sulfonates
Personnel: Bruno Stolley, manager

SHELL OIL CO. 290
Wilmington, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene—6,000,000 gal/yr
Toluene
Xylenes
Cyclohexane
Personnel: P. J. Merkus, Jr., manager

SHELL OIL CO. 291
Wood River, Ill.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Toluene
Xylene
Personnel: H. D. Dale, manager

SHELL OIL CO. 292
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene—19,000,000 gal/yr
Toluene—33,000,000 gal/yr
Sulfur—20,000 ton/yr
Personnel: J. A. Trench, manager

SID RICHARDSON CARBON CO. 293
Odessa, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks—80,000,000 lb/yr
Personnel: H. H. Offutt, manager; L. E. King, superintendent; H. M. Jones, chief engineer

SID RICHARDSON CARBON CO. 294
Odessa, Texas
Approximate investment: $190,000
Gross value, products: 1955—$160,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—9000 ton/yr
Personnel: G. M. Smith, manager

SID RICHARDSON GASOLINE CO. 295
Kermit, Texas
Hydrocarbon raw materials:
Natural Gas
Products and output:
Sulfur
Personnel: D. H. Huff, superintendent

SIGNAL OIL & GAS CO. 296
Tioga, No. Dak.
Approximate investment: $14,000,000
Hydrocarbon raw materials:
Casinghead gas
Products and output:
Sulfur
Personnel: R. L. Cook, superintendent; F. W. Norton, chief engineer

SIMPSON COAL & CHEMICAL CO. 297
Remarks: Project for a $20,000,000 ammonia plant at Natchez, Miss., have been abondoned.

SINCLAIR REFINING CO. 298
Wood River, Ill.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Aromatic solvents
Personnel: M. H. Nolan, manager

SINCLAIR REFINING CO. 299
East Chicago, Ind.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Cresylic acids
Gear, turbine & cutting oil additives
Personnel: E. W. Griscom, manager

SINCLAIR REFINING CO. 300
Wellsville, N. Y.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Petroleum resins
Personnel: W. B. Chenault, manager

SINCLAIR REFINING CO. 301
Sand Springs Okla.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Demulsifying agents
Corrosion inhibitors
Sulfonates, acid & oil layer types (sodium salt)
Personnel: J. G. Wisherd, manager

SINCLAIR REFINING CO. 302
Marcus Hook, Pa.
Hydrocarbon raw materials:
Catalytic reformate
Petroleum fractions
Refinery gas
Products and output:
Toluene
Para xylene (98%)
Mixed xylenes
High aromatic solvents
Dodecene
Cresylic acids
Sulfur—7,000 ton/yr
Personnel: R. J. Self, manager

SINCLAIR REFINING CO. 303
Corpus Christi, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Aromatic solvents
Personnel: E. B. Killick, manager

SINCLAIR REFINING CO. 304
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Refinery gases
Products and output:
Sulfonates (barium, calcium & sodium salts)
Corrosion inhibitors
Odorless solvents
Cresylic acids
Sulfur—10,500 ton/yr
Personnel: F. D. Seifer, manager
Remarks: $2,200,000 lube oil additives plant (petroleum sulfonates) went on stream late spring, 1956.

SOCONY MOBIL OIL CO. 305
Buffalo, N. Y.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Sodium sulfite
Personnel: T. C. Lockhart, manager

SOHIO CHEMICAL Co. 306
Lima, Ohio
Approximate investment: $17,000,000
Hydrocarbon raw materials:
Natural gas
Hydrogen (from reforming)
Products and output:
Anhydrous ammonia—109,500 ton/yr
Urea—43,750 ton/yr
Nitric acid—21,000 ton/yr
Nitrogen solutions—70,000 ton/yr
Dry ice—54,750,000 lb/yr
Personnel: D. G. Stevens, manager

L. SONNEBORN SONS, INC. 307
Petrolia, Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Sulfonates
Personnel: H. Schindler, manager

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 133-140. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 300 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

SOUTHERN NITROGEN CO., INC. 308
Savannah, Ga.
Approximate investment: $14,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—90,000 ton/yr
Nitric acid
Urea
Nitrogen solutions
Ammonium nitrate
Personnel: J. R. Riley, president; Richard F. Brown, vice pres.-operations; Neil S. Whitaker, production manager
Remarks: New company, established in 1955. Will use gas supplied by Southern Natural Gas Co. of Birmingham, Ala. Plant is scheduled for completion early in 1957.

SPENCER CHEMICAL CO. 309
Calumet City, Illinois
Hydrocarbon raw materials:
Methanol
Products and output:
Formaldehyde
Hexamine
Personnel: R. W. McKinnery, manager
Remarks: Methanol feedstock comes from Pittsburg, Kans., plant.

SPENCER CHEMICAL CO. 310
Pittsburg, Kans.
Approximate investment: $11,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—178,000 ton/yr
Methanol
Ammoniating solutions
Ammonium nitrate
Nitric acid
Carbon dioxide
Personnel: V. F. Hobart, manager

SPENCER CHEMICAL CO. 311
Henderson, Ky.
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—79,000 ton/yr
Nitric acid
Ammoniating solutions
Aqua ammonia
Personnel: R. D. White, manager; Geo. Frey, superintendent
Remarks: New facilities have been added for producing aqua ammonia. Another new unit for concentrated nitric acid is scheduled for completion early in 1957.

SPENCER CHEMICAL CO. 312
Vicksburg, Miss.
Approximate investment: $15,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—70,000 ton/yr
Ammoniating solutions
Nitric acid—36,500 ton/yr
Personnel: W. A. Johnston, manager

SPENCER CHEMICAL CO. 313
Fort Worth, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Liquid carbon dioxide
Dry ice
Personnel: R. R. Severns, manager
Remarks: Purchased February 1, 1956, from the Parker-Browne Co.

SPENCER CHEMICAL CO. 314
Orange, Texas
Approximate investment: $12,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Polyethylene—45,000,000 lb/yr
Personnel: Frank Pyle, manager

STANDARD OIL CO. OF CALIFORNIA 315
El Segundo, Calif.
Hydrocarbon raw materials:
Petroleum base stocks
Products and output:
Benzene
Toluene
Paraxylene
Cumene
Butadiene—butylene mixtures—50,000 ton/yr
Aliphatic acids
Gas odorants
Personnel: D. K. Harger, manager

STANDARD OIL CO. OF CALIFORNIA 316
Richmond, Calif.
Hydrocarbon raw materials:
Petroleum base stocks
Products and output:
Paraxylenes—35,000,000 lb/yr
Orthoxylene
Industrial xylenes
Alkyl aromatic detergents
Metallic naphthenates & naphthenic acids
Cresylic acids
Petroleum sulfonates
Polybutenes
Gas odorants
Ethyl mercaptans
Phthalic anhydride
Phenol—35,000,000 lb/yr
Acetone—20,000,000 lb/yr
Isophthalic acid—50,000,000 lb/yr
Nitric acid—90,000 ton/yr
Personnel: C. W. Rehfuss, general manager
Remarks: Under construction: Ammonia plant, 300 ton daily, for completion in September, 1956; Benzoic-toluic plant, for completion in November, 1956.

STANDARD OIL CO. (INDIANA) 317
Wood River, Ill.
Hydrocarbon raw materials:
Heptene heartcut
Petroleum fractions
Products and output:
Iso-octyl, decyl, or higher alcohols—14,000,000 lb/yr
Sodium cresylate
Polybutene and higher mol. wt. hydrocarbons
Lube oil detergent additives
Petroleum base plasticizers
Personnel: L. H. Butterworth, manager; S. E. Cahoon, R. A. Jack, assistant managers; J. K. Roedel, chief engineer

STANDARD OIL CO. (INDIANA) 318
Whiting, Ind.
Hydrocarbon raw materials:
Petroleum fractions
Refinery gases
Products and output:
Benzene—260,000 bbl/yr
Toluene—450,000 bbl/yr
Xylenes—220,000 bbl/yr
Sulfur—19,250 ton/yr
Detergent alkylate—55,000,000 lb/yr
Sodium cresylate
Personnel: A. F. Endres, manager; A. H. Hayes, C. H. Dougherty, A. S. Musselman, P. T. Oak, E. G. Whitley, assistant managers; P. L. Krauel, chief engineer

STANDARD OIL CO. (INDIANA) 319
Sugar Creek, Mo.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
C$_3$ olefin concentrate—117,000 bbl/yr
Personnel: H. R. Boehmer, manager; J. H. Johnsen, I. C. Staeuble, assistant managers; G. W. Larson, chief engineer
Remarks: Supplies raw material to Wood River Oxo alcohol units.

STANOLIND OIL & GAS CO. 320
Brownsville, Texas
(see Hidalgo Chemical Co.)

STANOLIND OIL & GAS CO. 321
North Cowden, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—6,200 ton/yr
Personnel: Errol R. Wagner, superintendent

STANOLIND OIL & GAS CO. 322
Odessa, Texas
Hydrocarbon raw materials:
Hydrogen sulfide
Products and output:
Sulfur—3,650 ton/yr
Personnel: E. R. Wagner, superintendent
Remarks: Sulfur recovery unit being added to existing Midland Farms Gasoline Plant. Completion date Sept., 1956.

STANOLIND OIL & GAS CO. 323
Sundown, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—17,150 ton/yr
Personnel: H. K. Boswell, superintendent

STANOLIND OIL & GAS CO. 324
Powell, Wyo. (Elk Basin Field)
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—23,700 ton/yr
Personnel: A. H. Denny, superintendent

STAUFFER CHEMICAL CO. 325
LeMoyne, Ala.
Hydrocarbon raw materials:
Natural gas & sulfur
Products and output:
Carbon disulfide
Personnel: Gordon Mitchell, manager

STAUFFER CHEMICAL CO. 326
Dominguez Jct., Calif.
Hydrocarbon raw materials:
Refinery gases
Acid sludge
Products and output:
Sulfuric acid
Personnel: W. E. H. Knight, manager

STAUFFER CHEMICAL CO. 327
Hammond, Ind.
Approximate investment: $2,000,000
Hydrocarbon raw materials:
Refinery acid sludge
Products and output:
Sulfuric acid
Personnel: Geo. Schiffbauer, manager

STAUFFER CHEMICAL CO. 328
Louisville, Ky.
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Propane—propylene
Products and output:
Carbon tetrachloride
Perchlorethylene
Hydrogen chloride
Chloroform
Methylene chloride
Personnel: H. L. McLean, superintendent
Remarks: New chloroform and methylene chloride unit scheduled for completion in mid-1957.

STAUFFER CHEMICAL CO. (Consolidated Chemical Div.) 329
Baton Rouge, La.
Hydrocarbon raw materials:
Acid sludge
Products and output:
Sulfuric acid—140,000 ton/yr
Personnel: W. J. Dospit, manager

STAUFFER CHEMICAL CO. (Consolidated Chemical Div.) 330
Baytown, Texas
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Acid sludge
Products and output:
Sulfuric acid—140,000 ton/yr
Personnel: Z. L. Evans, manager

STAUFFER CHEMICAL CO. (Consolidated Chemical Div.) 331
Houston, Texas
Aproximate investment: $4,000,000
Hydrocarbon raw materials:
Acid sludge
Products and output:
Sulfuric acid—140,000 ton/yr
Personnel: O. D. Massey, manager

SUN OIL CO. 332
Toledo, Ohio
Hydrocarbon raw materials:
Refinery streams
Products and output:
Butylenes
Propylene tetramer (Dodecene)
Hydrogen
Personnel: J. F. Harron, manager; H. C. Thaber, superintendent; J. L. Barker, chief engineer

SUN OIL CO. 333
Marcus Hook, Penna.
Hydrocarbon raw materials:
Refinery streams
Products and output:
Benzene—19,000,000 gal/yr
Toluene—30,000,000 gal/yr
Xylene—18,000,000 gal/yr
Petroleum sulfonates
Naphthenic acids
Propylene tetramer (Dodecene)
Propylene trimer (Nonene)
Ammonia—109,500 ton/yr
Sulfur—10,800 ton/yr
Personnel: C. C. Naylor, manager; W. C. Huffman, superintendent; F. W. Bowen, chief engineer

SUNRAY OIL CORP. 334
Duncan, Okla.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Propylene tetramer
Personnel: R. L. Johnson, manager
Remarks: Wholly-owned subsidiary of Sunray Mid-Continent Oil Co.

SUNTIDE REFINING CO. 335
Corpus Christi, Texas
Approximate investment: $2,175,000
Gross value, products: 1955—$1,048,169 (est.) 1956—$1,512,000
Hydrocarbon raw materials:
Propylene

Naphtha
Products and output:
Tetramer—150,000 bbl/yr
Benzene—140,000 bbl/yr
Toluene—315,000 bbl/yr
Xylene—550,000 bbl/yr
Personnel: H. G. Gunter, manager; A. T. Smith, superintendent; L. W. Plummer, chief engineer
Remarks: Suntide is constructing a 15,000 b/d Rexformer, with a Unifiner and a Udex extraction unit to produce benzene, toluene and xylene in the volumes shown above. Completion is scheduled for May, 1957. The investment figure shown is for the tetramer plant only.

T

TENNESSEE EASTMAN CO. 336
Kingsport, Tenn.
Hydrocarbon raw materials:
Natural gas or LPG
Products and output:
Hydrogen
Personnel: Dr. F. R. Conklin, general manager
Remarks: Company is building semi-commercial plant for new acrylic fibre—"Verel"; is expanding mfg. facilities for "Tenite."

TEXAS BUTADIENE & CHEMICAL CORP. 337
Channelview, Texas
Approximate investment: $21,000,000
Hydrocarbon raw materials:
Butanes
Products and output:
Butadiene—65,000 ton/yr
Butylenes
Alkylate
Remarks: Plant will be able to make up to 2,500,000 bbl/yr of alkylate by cutting butadiene to 17,000 ton/yr. Design and engrg. contractor is Fluor Corp. Completion date: Early 1957.

THE TEXAS CO. 338
Lockport, Illinois
Hydrocarbon raw materials:
Refinery gas
Products and output:
Anhydrous ammonia—64,800 ton/yr
Nitrogen solutions
Personnel: E. W. McNeally, superintendent
Remarks: Under construction. Completion date is November, 1957.

THE TEXAS CO. 339
Port Arthur, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Naphthenic acids
Sulfonates
Butylenes
Propylene tetramer
Propylene trimer
Diisobutylene
Gasoline and furnace oil additives
Lubricating oil additives
Personnel: F. L. Wallace, manager

TEXAS EASTMAN CO. 340
(Div. of Eastman Kodak Co.)
Longview, Texas
Hydrocarbon raw materials:
Propane and natural gas
Products and output:
Butyraldehydes
2-ethyl hexanol
2-ethyl isohexanol
Isobutyl alcohol
Isobutyronitrile—40,000,000 lb/yr
Ethyl alcohol
Polyethylene
Personnel: D. C. Hull, manager; W. R. Saunders, superintendent; W. R. Burton, chief engineer
Remarks: Polyethylene capacity is being expanded to 40,000,000 lb/yr with completion scheduled for late in 1956. Facilities now under construction to make neopentyl glycol, trimethyl pentanediol, propionaldehyde, valeraldehydes, and higher plasticizer alcohols.

TEXAS GAS CORP. 341
Winnie, Texas
Personnel: Mixson Kincannon, manager; Tom Neville, superintendent
Remarks: No petrochemical products being made at present.

TEXAS GULF SULPHUR CO. 342
Worland, Wyo.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—90,000 ton/yr
Personnel: J. W. Estep, manager

TEXAS-U. S. CHEMICAL CO. 343
Port Neches, Tex.
Remarks: See Neches Butane Products Co.

THERMATOMIC CARBON CO. 344
Sterlington, La.
Gross value, products: 1955—$4,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon black—100,000,000 lb/yr
Personnel: R. W. Cretney, vice president and general manager; S. S. Gill, superintendent

THUNDERBIRD CHEMICALS, INC. 345
Kyrene, Arizona
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—43,200 ton/yr
Urea—16,200 ton/yr
Sulfuric acid—61,200 ton/yr
Remarks: In planning stage. Design and construction under direction of Tellepsen Petro-Chem Constructors.

TIDE WATER OIL CO. 346
Delaware City, Del.
Hydrocarbon raw materials:
Sour refinery streams
Products and output:
Sulfur
Remarks: New refinery, under construction

U

UNION OIL CO. OF CALIFORNIA 347
Oleum, Calif.
Approximate investment: $600,000
Hydrocarbon raw materials:
Refinery gases and wastes
Products and output:
Sulfur—18,250 ton/yr
Personnel: M. S. Thomson, manager

UNION OIL CO. OF CALIFORNIA 348
Santa Maria, Calif.
Approximate investment: $1,575,000
Hydrocarbon raw materials:
Refinery and natural gases
Products and output:
Sulfur—30,000 ton/yr
Dry ice and carbon dioxide—18,250 ton/yr
Personnel: R. A. McKean, superintendent

UNION OIL CO. OF CALIFORNIA 349
Wilmington, Calif.
Approximate investment: $1,800,000
Hydrocarbon raw materials:
Refinery gases and wastes
Products and output:
Sulfur—14,000 ton/yr
Ammonium sulfate—20,000 ton/yr
Methyl and ethyl mercaptans—500,000 lb/yr
Personnel: J. W. Towler, manager

UNITED CARBON CO., INC. 350
Ryus, Kans.
Hydrocarbon raw materials:
Natural gas and oil
Products and output:
Furnace blacks
Personnel: G. A. Way, superintendent

UNITED CARBON CO., INC. 351
Franklin, La.
Hydrocarbon raw materials:
Natural gas and oil
Products and output:
Furnace blacks
Personnel: M. J. Graham, superintendent

UNITED CARBON CO., INC. 352
Rayville, La.
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks
Personnel: J. H. Mann, superintendent

UNITED CARBON CO., INC. 353
Eunice, N. Mex.
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks
Personnel: L. L. Eubanks, superintendent

UNITED CARBON CO., INC. 354
Aransas Pass, Texas
Hydrocarbon raw materials:
Natural gas and oil
Products and output:
Furnace and channel blacks
Personnel: Frank Gathright, superintendent

UNITED CARBON CO., INC. 355
Borger, Texas
Remarks: Plant has been dismantled

UNITED CARBON CO., INC. 356
Falfurrias, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks

UNITED CARBON CO., INC. 357
Shamrock, Texas
Hydrocarbon raw materials:
Natural gas and oil
Products and output:
Furnace blacks
Personnel: H. L. Teegerstrom, superintendent

UNITED CARBON CO., INC. 358
Stinnett, Texas
Remarks: Plant has been dismantled.

UNITED RUBBER AND CHEMICAL CO. 359
Baytown, Texas
Approximate investment: $8,838,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
GR-S rubber—44,000 ton/yr
Personnel: Ted Lyman, manager and vice president
Remarks: United Rubber and Chemical Co. is new, wholly-owned subsidiary of United Carbon Co.

U. S. INDUSTRIAL CHEMICALS CO. 360
(A Div. of National Distillers Products Corp.)
Tuscola, Ill.
Approximate investment: $12,000,000
Hydrocarbon raw materials:
Natural gas streams
Products and output:
Anhydrous ammonia—45,000 ton/yr
Nitrogenous fertilizers
Sulfuric acid—140,000 ton/yr
Personnel: D. J. Patterson, manager; Wm. Powell, assistant manager; Wm. Mendel, chief engineer
Remarks: Catalytic Construction Co. has an engineering and construction contract for a 10,000,000 lb/yr isosebacic acid plant, to be completed early in 1957. A phosphoric acid plant (capacity 60,000 lb/yr of 75% phosphoric acid) will be completed in late 1956.

U. S. RUBBER CO. 361
(Naugatuck Chemical Division)
Naugatuck, Conn.
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
Synthetic rubber S-type—22,200 ton/yr
Personnel: P. E. Rice, manager; W. T. Ford, superintendent; L. A. Doherty chief engineer

U. S. RUBBER CO. 362
(Naugatuck Chemical Division)
Joliet, Ill.
Hydrocarbon raw materials:
Toluene
Products and output:
Explosives
Remarks: Information restricted by government security regulations.

U. S. RUBBER CO. 363
(Naugatuck Chemical Division)
Baton Rouge, La.
Hydrocarbon raw materials:
Butadiene
Styrene
Acrylonitrile
Products and output:
Synthetic rubber N-type
High impact resins
Personnel: J. S. Brown, manager; J. M. Poynter, superintendent; J. M. Reardon, chief engineer

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 133-140. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 300 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

UNIVERSAL DETERGENTS, INC. 364
Long Beach, Calif.
Approximate investment: $1,200,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alkyl aryl sulfonates—4320 ton/yr
Aromatic solvents—60,000 bbl/yr
Personnel: B. R. Bryant, general manager

UTAH CHEMICAL CO. 365
Mt. Pleasant, Utah
Approximate investment: $9,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—54,000 ton/yr
Personnel: N. G. Morgan, Jr., president
Remarks: New plant, still in planning stages.

V & W

VELSICOL CORP. 366
Marshall, Ill.
Hydrocarbon raw materials:
Petroleum base stocks
Products and output:
Benzene
Toluene
Xylenes
Petroleum polymers
Petroleum resins
Insecticides
Mixed aromatic solvents
Personnel: W. Camp, plant manager; W. Keyes, assistant manager; W. K. McCready, manager

VISCO PRODUCTS CO. 367
Anaheim, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Oil treating chemicals
Personnel: E. T. Kocher, manager

VISCO PRODUCTS CO. 368
Sugar Land, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Oil treating chemicals
Personnel: W. H. Kirkpatrick, vice president

WARREN PETROLEUM CORP. 369
Monument, N. Mex.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur
Personnel: L. A. Walker, superintendent
Remarks: Plant is owned by Allied Chemical & Dye Corp., and operated by Warren.

WARREN PETROLEUM CORP. 370
Conroe, Texas
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Propane
Butane
Ethane
Products and output:
Pentaerythritol
Acetaldehyde
Formaldehyde
Methanol
Solvents
Personnel: K. A. Fisher, manager; Sam Summers, superintendent
Remarks: Company plans expansion in the three existing products, plus new facilities for formaldehyde, methanol, and solvents.

WARWICK WAX CO., INC. 371
Chanute, Kans.
Gross value, products: 1955—$3,500,000
(est.) 1956—$4,000,000
Hydrocarbon raw materials:
Crude oil sediments
Products and output:
Petroleum waxes—15,000,000 lb/yr
Personnel: G. Hatfield, manager

WESTVACO CHLOR-ALKALI DIVISION
(Food Machinery & Chemical Corp.) 372
So. Charleston, W. Va.
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon bisulfide
Personnel: R. J. De Largey, manager; N. Elphick, superintendent; L. Hundley, chief engineer.

WILSHIRE OIL CO. OF CALIFORNIA 373
Norwalk, Calif.
Approximate investment: $175,000
Gross value, products: 1955—$124,000
(est.) 1956—$124,000
Hydrocarbon raw materials:
H_2S from fuel gas
Products and output:
Sulfur—3,942 ton/yr
Personnel: J. H. Ouding, manager; L. Earl, superintendent; S. Lindsay, chief engineer

WYANDOTTE CHEMICALS CORP. 374
Baton Rouge, La.
Approximate investment: $8,000,000
Products and output:
Ethylene oxide
Remarks: Company bought 700 acres and has option on 500 more along Mississippi River, 25 miles south of Baton Rouge. Completion expected in 4th quarter of 1957.

WYANDOTTE CHEMICALS CORP. 375
Wyandotte, Mich.
Approximate investment: $7,000,000
Hydrocarbon raw materials:
Crude oil and fractions
Products and output:
Ethylene glycol
Diethylene glycol
Ethylene dichloride
Chlorinated solvents
Alkyl aryl sulfonate
Synthetic detergents
Sodium carboxy-methyl cellulose
Personnel: Bert Cremers, manager; John Reifel, superintendent; L. W. Munchmeyer, chief engineer

WYNN OIL CO. 376
Azusa, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil aids
Radiator additives
Fuel additives
Lube oil additives
Personnel: John T. Appelt, manager

Petrochemical Plants in Canada

B. A. SHAWINIGAN LTD. 377
Montreal East, Que.
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Cumene
Products and output:
Phenol—20,000,000 lb/yr
Acetone—8,000,000 lb/yr
α-Methyl styrene—2,000,000 lb/yr
Isopropanol—4,000,000 lb/yr
Personnel: R. H. Hall, manager; R. B. Walker, chief engineer
Remarks: Plant expansion in progress to increase capacity 50% in 1957.

BAKELITE CO.
(Div. of Union Carbide Canada, Ltd.) 378
Belleville, Ont.
Hydrocarbon raw materials:
Methanol
Products and output:
Formaldehyde
Phenolic resins
Personnel: F. Perry Wilson, president; J. C. McDonald, superintendent; G. A. Bradford, engineer

BRITISH AMERICAN OIL CO., LTD. 379
Pincher Creek, Alberta
Approximate investment: $7,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—82,000 long tons/yr
Condensate—800,000 bbl/yr
Remarks: Plant under construction, with completion date of Oct., 1956, is designed to recover only sulfur and condensate from the Pincher Creek field. This was formerly Canadian Gulf Oil Corp. project.

BRITISH AMERICAN OIL CO. LTD. 380
Montreal, Que.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Cumene—36,000,000 lb/yr
Personnel: J. A. McHardy, manager
Remarks: Cumene is raw material for B. A.—Shawinigan.

BRITISH DOMINION OIL CO. 381
(See Northwest Nitro-Chemicals Ltd.)

CABOT CARBON OF CANADA LTD. 382
Sarnia, Ont.
Approximate investment: $4,500,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Furnace carbon blacks—60,000,000 lb/yr
Personnel: P. H. Delacour, executive vice president; W. F. Hendricks, resident manager; J. A. Satterfield, superintendent; A. J. McKenzie, chief engineer.

CANADIAN CHEMICAL CO., LTD. 383
Edmonton, Alberta
Approximate investment: $80,000,000
Hydrocarbon raw materials:
Butane
Propane
Natural gas
Products and output:
Propylene glycol
Propylene oxide
Pentaerythritol
Alcohols
Aldehydes
Esters
Ketones
Acetic acid and anhydride
Cellulose acetate
Solvents
Personnel: V. T. Anwyll, manager; H. K. Busch, prod. manager; J. C. Langford, chief engineer
Remarks: Company is wholly-owned by Canadian Chemical and Cellulose Company, Ltd., and also produces cellulose acetate, staple fibre and filament yarns at Edmonton.

CANADIAN GULF OIL CORP. 384
Pincher Creek, Alberta
Remarks: See British American Oil Co.

CANADIAN HYDROCARBONS, LTD. 385
Winnipeg, Manitoba
Approximate investment: $1,500,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—29,200 ton/yr
Nitrogenous fertilizers—219,000 ton/yr
Remarks: New company incorporated early in 1955 by Winnipeg & Central Gas Co. Plant in planning stages.

CANADIAN INDUSTRIES, LTD. 386
Edmonton, Alberta
Approximate investment: $15,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Polyethylene—22,600,000 lb/yr
Personnel: S. T. Jones, manager; G. R. McElroy, works engineer

CANADIAN INDUSTRIES, LTD. 387
Millhaven, Ontario
Approximate investment: $9,000,000
Hydrocarbon raw materials:
Residual oil
Products and output:
Anhydrous ammonia—67,000 ton/yr
Personnel: A. A. Perley, manager
Remarks: Plant is under construction. Completion scheduled for Oct., 1956.

CANADIAN INDUSTRIES, LTD. 388
Millhaven, Ont.
Approximate investment: $20,000,000
Hydrocarbon raw materials:
Ethylene glycol
Dimethylterephthalate

Products and output:
"Terylene"—11,000,000 lbs.
Personnel: H. M. Sherwood, manager; R. B. Wotherspoon, works engineer

CANADIAN OIL COS., LTD. 389
Pincher Creek, Alberta
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—81,000 ton/yr
Remarks: Project was announced in March, 1956.

CANADIAN OIL COS., LTD. 390
Sarnia, Ont.
Hydrocarbon raw materials:
Aromatics
Products and output:
Benzene
Toluene
Xylenes
Remarks: Company is building a second Platformer-Udex unit, with Udex capacity of 3650 b/d to produce pure B-T-X chemicals. Completion of the $3,000,000 unit is expected by Aug., 1957.

CARBIDE CHEMICALS CO.
(**Div. of Union Carbide Canada Ltd.**) 391
Montreal East, Que.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Ethylene glycol
Ethylene oxide
Polyethylene
Personnel: H. D. Lyon, plant manager; R. S. Hughes, staff engineer
Remarks: An integrated ethylene glycol, ethylene oxide and derivatives plant scheduled for completion, December, 1956. Fully integrated polyethylene plant schedule for completion early in 1957.

THE CONSOLIDATED MINING AND SMELTING CO. OF CANADA, LTD. 392
Calgary, Alberta
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—130,000 ton/yr
Ammonium nitrate
Personnel: R. S. Woodford, superintendent

DOW CHEMICAL OF CANADA, LTD. 393
Sarnia, Ontario
Hydrocarbon raw materials:
Refinery gases
Products and output:
Ethylene
Ethylene oxide
Ethylene glycol
Diethylene glycol
Triethylene glycol
Carbon tetrachloride
Perchloroethylene
Trichloroethylene
Hydrochloric acid
Ammonia
Styrene monomer
Styrene-butadiene latexes
Polystyrene
Personnel: P. D. Scott, manager; J. L. Smart, assistant manager; G. B. MacCoy, chief engineer
Remarks: Dow has a $10-million construction program underway. These facilities will provide for production of the following materials: ethanolamine, additional ethylene, increased chlorine and caustic soda, styrofoam, additional ethylene-glycol.

DU PONT CO. OF CANADA, LTD. 394
Maitland, Ont.
Hydrocarbon raw materials:
Cyclohexane
Products and output:
Hexamethylene diamine
Adipic acid
Personnel: A. T. Fell, manager

ETHYL CORP. OF CANADA, LTD. 395
Sarnia, Ont.
Approximate investment: $14,000,000
Hydrocarbon raw materials:
Ethane and ethylene
Products and output:
Anti-knock fluids
Personnel: A. C. Tully, president; O. B. Lewis, vice president; R. T. Edgar, manager; E. F. Diedrich, assistant manager; C. L. Weeks, chief engineer
Remarks: New plant, scheduled for completion Sept. 1956.

B. F. GOODRICH, CANADA, LTD. 396
Niagara Falls, Ont.
Approximate investment: $3,500,000
Products and output:
Polyvinyl chloride
Remarks: Project was announced late in 1955.

IMPERIAL CHEMICAL INDUSTRIES OF CANADA, LTD. 397
Millhaven, Ont.
(See Canadian Industries Ltd.)

IMPERIAL OIL LTD. 398
Sarnia, Ont.
Approximate investment: $3,800,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Dodecyl benzene—30,000,000 lb/yr
Tripropylene
Tetrapropylene
Alkylaromatics
Remarks: Plant is in planning stage. Completion scheduled for mid-1957.

INLAND CHEMICALS OF CANADA, LTD. 399
Fort Saskatchewan, Alberta
Approximate investment: $1,000,000
Gross value, products: 1955—$129,800
(est.) 1956—$750,000
Hydrocarbon raw materials:
Sulfur
Products and output:
Sulfuric acid—36,500 ton/yr
Personnel: G. S. Grant, manager; S. M. Sumka, superintendent
Remarks: Sulfur comes from Shell at Jumping Pound. Plant went onstream Sept. 1, 1955, and turned 2200 tons of sulfur into 5115 tons of acid during the balance of that year.

JEFFERSON LAKE SULPHUR CO. 400
Ft. St. John, B. C.
Approximate investment: $1,800,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—108,000 ton/yr
Remarks: A joint operation with Pacific Petroleum Ltd. Plant will operate on gas feed from Pacific's new natural gasoline plant being built at Ft. St. John. Completion date: 1957.

LUBRIZOL OF CANADA, LTD. 401
Niagara Falls, Ont.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Personnel: M. A. Payne, manager

MONSANTO CANADA, LTD. 402
Montreal, Que.
Hydrocarbon raw materials:
Petroleum base stock
Products and output:
Polystyrene
Personnel: D. D. Stokes, general sales manager

S. NORD CHEMICAL CO. 403
Petrolia, Ont.
Approximate investment: $1,500,000
Hydrocarbon raw materials:
Catalytic reformate
Products and output:
Benzene
Toluene
Xylenes
Total B-T-X—30,000,000 gal/yr
Naphthas
Personnel: Sol Nord, Manager
Remarks: Expansion program scheduled for completion at end of 1956.

NORTHWEST NITRO-CHEMICALS, LTD. 404
Medicine Hat, Alberta
Approximate investment: $22,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Nitrogeneous fertilizers
Personnel: C. W. Hancock, manager
Remarks: A new company, organized by Commercial Solvents Corp. (who will manage and operate the venture), New British Dominion Oil Co. Ltd.; Ford, Bacon & Davis, Inc.; and Mr. Frank McMahon. The plant is scheduled for completion fall of 1956.

POLYMER CORP., LTD. 405
Sarnia, Ont.
Approximate investment: $70,000,000
Gross value, products: 1955—$61,000,000
Hydrocarbon raw materials:
Refinery gases
Products and output:
Styrene monomer
Ethylene
Isobutylene
Butyl rubbers
Butadiene rubbers
(103,300 long tons/yr of all types of rubbers were produced in 1955.)
Personnel: L. D. Dougan, plant manager

POLYMER CORP. LTD. 406
Western Canada
Hydrocarbon raw materials:
Natural gas
Products and output:
Butadiene
Remarks: Polymer is considering new butadiene facilities in Western Canada, and such consideration is related to the supply of butane which may become available as a result of Trans-Canada pipe line.

QUEBEC AMMONIA CO., LTD. 407
Maitland, Ont.
Approximate investment: $8,500,000
Hydrocarbon raw materials:
Fuel oil
Products and output:
Ammonia—43,800 ton/yr
Remarks: In planning stage. Plant is to operate ultimately on natural gas as soon as it is available.

ROYALITE OIL CO., LTD. 408
Turner Valley, Alberta
Gross value, products: 1955—$276,000
(est.) 1956—$278,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—14,400 tons
Personnel: C. J. Pearson, superintendent

ST. MAURICE CHEMICAL CO. 409
Varennes, Que.
Hydrocarbon raw materials:
Methanol
Acetaldehyde
Products and output:
Formaldehyde
Pentaerythritol
Personnel: Hal Norton, manager
Remarks: Company owned jointly by Shawinigan Chemicals Co. and Heyden Chemical Corp.

SHELL OIL CO. OF CANADA, LTD. 410
Jumping Pound, Alberta
Approximate investment: $1,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—28,800 long ton/yr
Personnel: R. E. Mitchell, superintendent

SHELL OIL CO. OF CANADA, LTD. 411
Montreal, Que.
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Butylene
Propylene
Benzene
Products and output:
Isopropyl alcohol
Acetone
Total alcohol & acetone—36,000,000 lb/yr
Methyl ethyl ketone
Secondary butanol
Dodecyl benzene
Personnel: L. T. Wilson, manager; J. E. Nichol, chemical plant superintendent
Remarks: Isopropyl alcohol and acetone in operation since February 1953. Secondary butyl alcohol and MEK to be completed late 1956. Dodecyl benzene to be completed mid-1957. Current expansion will add $3,500,000 to total investment.

SHERRITT GORDON MINES, LTD.
(**Chemical Metallurgical Div.**) 412
Fort Saskatchewan, Alberta
Approximate investment: $25,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—3500 ton/yr (net)
Ammonium sulfate—75,000 ton/yr
Personnel: W. H. Young, manager; C. A. Hames, V. N. McKim, assistant managers
Remarks: Ammonia is used in treating nickel concentrates from company mine at Lynn Lake, Man. The ammonium sulfate is a by-product of the process.

STANDARD CHEMICAL CO., LTD.
(See Carbide Chemicals Co., Ltd.) 413

SUN OIL CO., LTD. 414
Sarnia, Ont.
Hydrocarbon raw materials:
Refinery streams
Products and output:
Butylenes
Hydrogen
Personnel: G. R. Henderson, manager; F. A. Bain, superintendent; P. Monsen, chief engineer

SURPASS PETROCHEMICALS, LTD. 415
Scarborough, Ont.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Rust preventives
Engine oil additives
Remarks: Plant still in planning stages.

Which Plants Make What Petrochemicals?

. . . plus brief descriptions of nearly 300 petrochemicals

THE FOLLOWING PAGES are an added feature of your 1956 Petrochemical Plants Survey aimed at making it more helpful to you. Starting below is a glossary of almost 300 important petrochemical products, as well as an index to the plant survey of the preceding 16 pages.

You will find this new feature useful in two ways:

1—You can find out who makes what products in which plants. Code numbers following the name of each petrochemical material correspond to numbers following the name of each company plant in the directory. If you want to know who is making acetaldehyde, for example, and where: look for "acetaldehyde" in the glossary. Using the numbers after "acetaldehyde," refer back to the plant listings.

2—You can learn more about the material itself—its chemical composition, principal physical properties, how it's made, and where it's used. Physical properties have been abbreviated for convenience: BP means boiling point; FP is freezing point; MP is melting point; SG is specific gravity, and D is density.

Three points should be kept in mind when this glossary is used:

1—This is not a markets listing. Many materials reported by the manufacturers are not for sale. They are only captive, or intermediate, products.

2—The code system for locating the manufacturers' plants is based on the survey of plants itself. This survey in turn is based only on information reported to the Editors by the individual companies. Because some firms prefer not to report all specific products, no claim can be made for the completeness of this glossary with respect to all manufacturers.

3—It was not the intention of the Editors to make this glossary a complete chemical history. We are reporting only the petrochemical routes to the material, and we have ignored most of the non-petroleum sources (e.g. coal tar for benzene).

ACETAL (Diethylacetal, Diethylaldehyde)—52

$CH_3CH(OC_2H_5)_2$. Colorless liq. BP 216°F (102.2°C), D 6.89 lb/gal. Made by partial oxidation of ethyl alcohol, with first-formed acetaldehyde condensing with the alcohol. Used as general solvent; chemical intermediate.

ACETALDEHYDE (Ethanal, Ethyl Aldehyde)—57, 58, 174, 370

CH_3CHO. Colorless liq. BP 68.4°F (20.2°C), FP −190.3°F (−123.5°C), SG 0.783 (18/4°C). Made by dehydrogenation or oxidation of ethyl alcohol; oxidation of propane or butane; or water-acetylene reaction. Used to mfr. acetic acid and anhydride, n-butyl alcohol, 2-ethylhexanol, paraldehyde, pentaerythritol and substituted pyridines; phenolic resins, synthetic rubber.

ACETIC ACID (Methanecarboxylic Acid)—48, 50, 51, 57, 58, 174, 383

CH_3COOH. Colorless liq. BP 244.6°F (118.1°C), MP 61.9°F (16.6°C). D 8.64 lb/gal (20°C). Made by acetaldehyde or hydrocarbon gas oxidation. Used to mfr. acetic anhydride synthetic fibers, plastics, synthetic rubber coagulation; acidifying agent; solvent.

ACETIC ANHYDRIDE (Acetyl Oxide, Acetic Oxide)—48, 50, 51, 58, 383

$(CH_3CO)_2O$. Colorless liq. BP 283.8°F (139.9°C), FP −90.4°F (−68°C), den. 9.0 lb/gal (20°C). Made by acetaldehyde oxidation; from acetylene via ethylidene diacetate from acetylene-acetic acid reaction; ketene-acetic acid reaction; or distilling acetyl chloride with sodium acetate. Used to mfr. acetate rayon, cellulose acetate products.

ACETONE (Dimethylketone, Propanone)—50, 57, 129, 170, 174, 316, 377, 411

CH_3COCH_3. Colorless liq. BP 133°F (56.1°C), MP −137.7°F (−94.3°C), den. 6.64 lb/gal (15°C). Made by isopropyl alcohol oxidation; or acetylene-water reaction. Used as solvent; to mfr. plastics, surface coatings, adhesives; wax purification; aerosol component; acetylene absorbent.

ACETONE CYANHYDRIN (Acetone cyanohydrin)—272

$(CH_3)_2COHCN$. Colorless liq. BP 179.6°F (82°C at 23 mm Hg), FP −4°F (−20°C), SG 0.932 (19°C). Made by acetone-hydrocyanic acid condensation. Used as insecticide to mfr. methyl methacrylate.

ACETOPHENONE (Phenylmethyl Ketone, Acetyl Benzene)—170

$C_6H_5COCH_3$. Colorless liq. or transparent crystals. BP 395.6°F (202°C), MP (congealing) 66.2°F (19°C), SG 1.026. Made by ethylbenzene oxidation or benzene-acetic anhydride or benzene-acetyl chloride reactions. Used as cellulose resin solvent; corrosion inhibitors. Potential use in synthetic resins and rubbers; solvent coating vinyl.

ACETYLENE (Ethine, Ethyne)—13, 50, 127

$CHCH$. Colorless gas. BP −119.2°F (−84°C), SG 0.91. Made by natural gas or hydrocarbon pyrolysis. Used in German "Reppe Chemie" reactions; to mfr. vinyl chloride, Neoprene synthetic rubber, trichlorethylene, acrylonitrile, vinyl acetate, acetylene black, electrically-conductive rubber and plastics.

ACROLEIN (Acraldehyde, Allyl Aldehyde, Acrylic Aldehyde, Propenal)—287

CH_2CHCHO. Colorless-to-yellow liq. BP 126.5°F (52.5°C), MP −125.9°F (−87.7°C), SG 0.84. Made by propylene oxidation; from propylene via production and allyl alcohol oxidation; or glycerine dehydrogenation. Used as extraction solvent; for mfr. of many not-yet-commercial chemicals. Potential uses as mfr. glycerine, methionine, plastics.

ACRYLONITRILE (Propenenitrile, Vinyl Cyanide)—13, 61, 203

CH_2CHCN. Colorless liq. BP 171.3°F (77.4°C), MP −117.4°F (−83°C). Dens. 6.7 lb/gal (20°C). Made from ethylene and hydrogen cyanide via mfr. and dehydration of ethylene cyanohydrin; or acetylene-hydrogen cyanide reaction. Used to mfr. Buna-N rubber, plastics, synthetic fibers, polyacrylonitriles, amines or acids. Potential use in cyanoethylation of cotton.

ADDITIVES (Cutting Oil)—12, 299, 339

Organic sulfur, chlorine, or phosphorous compounds added to mineral oils to reduce friction at the chip-tool interface in relatively low-speed, heavy-duty metal-cutting operations.

ADDITIVES (Lubricating Oils)—12, 27, 54, 55, 129, 192, 193, 207, 216, 276, 254, 282, 299, 304, 337, 339, 376, 401, 415

Organic chemicals, derived from petroleum, added to lubricating oils to act as boundary lubricants, detergents or dispersants, extreme-pressure agents, emulsifiers, foam depressants, oxidation inhibitors, polymeric thickeners or viscosity-index improvers, pour-point depressants, rust preventives, or wear inhibitors.

ADIPIC ACID (Butanedicarboxylic Acid, Hexanedioic Acid)—122, 394

$COOH(CH_2)_4COOH$. Colorless-to-yellowish cryst. BP 509°F (265°C) (100 mm Hg), MP 305.6°F (152°C), SG 1.360 (20/4°C). Made by cyclohexane oxidation (directly or via synthesis of cyclohexanone or cyclohexanol); via phenol hydrogenation to cyclohexanol; or from butadiene. Used to mfr. nylon hexamethylene diamine, adipates, polyurethanes, plastics, resins and synthetic rubber.

ADIPONITRILE (Hexanedinitrile, 1, 4-dicyanobutane)—123

$CN(CH_2)_4CN$. Colorless liq. BP 582.8°F (306°C), SG 0.962 (20/4°C). Made by 1, 4-dichlorobutane-sodium cyanide reaction, or passing ammonia through adipic acid in presence of phosphates. Used to mfr. hexamethylene diamine (for nylon mfr).

ALCOHOLS—50, 52, 272, 280, 282, 288, 383

ROH. (R is hydrocarbon radical) whether aliphatic, alicyclic, or aromatic-aliphatic. Only one hydroxyl group (OH) may be attached to one carbon atom, but molecule may have several hydroxyl groups (polyhydric alcohols). Colorless liquids or solids depending on type. Made by paraffinic hydrocarbons oxidation, or olefinic hydrocarbons hydration, or synthesis from carbon monoxide and hydrogen. Used as solvents, chemical intermediates, etc.

ALDEHYDES—52, 383

RCHO (R is any hydrocarbon radical). Liquids or solids, except formaldehyde (a gas). Made by alcohol oxidation or dehydrogenation, or olefins oxidation, or glycol oxidation. Used as chemical intermediates.

ALDRIN — (Hexachloro-hexahydro-dimethano-naphthalene)—286

$C_{12}H_8Cl_6$. White cryst. solid, MP 219.2-220.1°F (104-104.5°C). Made from petroleum-derived naphthalene. Used as insecticide.

ALIPHATIC ACIDS—315

RCOOH (R is an aliphatic hydrocarbon radical). E. g., see Acetic acid, Propionic acid. Made by alcohol or aldehyde oxidation; or ester, amide, acid chloride, nitrile, or acid anhydride. Used as chemical intermediate.

ALIPHATIC NAPHTHAS—273

Open-chain petroleum hydrocarbon fractions. Various naphthas have different boiling ranges; e.g., ligroin or petroleum ether boils 68-275°F; dry-cleaning solvent boils over 300-400°F range. From fractionation or extraction of paraffinic or mixed-base crudes. Used as solvents, paint thinners.

ALKYL AROMATIC DETERGENTS, see Sulfonated alkyl benzenes—316, 398

ALKYL ARYL SULFONATES, see Sulfonated alkyl benzenes—364, 375

ALKYLATE (Detergent)—318

$C_{12}H_{25}C_6H_5$, dodecylbenzene. Made by benzene-dodecene alkylation. Used to mfr. synthetic detergents. See also Sulfonated alkyl benzenes.

ALKYLATE (Gasoline)—337

C_8H_{18}, isomeric octanes. Colorless liquids. BP in C_8 gasoline range. Made by isobutane-butylene alkylation. Used as high-octane gasolines component.

ALKYLATED CRESOLS—188

$(R)_xC_6H_{3-x}OH$ (R is alkyl group). E.g., di-tert-butyl-p-cresol, colorless solid, BP 509°F (265°C), MP 158°F (70°C). Made by cresol alkylation. Used as antioxidant for lubricating oils and rubber, stabilizer for cracked gasolines.

CH_2CHCH_2Cl. Colorless liq. BP 113.2°F (44.9°C), SG 0.9374 (20/4°C). Made by propylene chlorination. Used as chemical intermediate.

ALPHA METHYL STYRENE (Vinyltoluene Isomer)—114, 377

$C_6H_5C(CH_3)CH_2$. Colorless liq. BP 329.7°F (165.38°C), MP —9.8°F (—23.21°C), SG 0.9062 (25/25°C). Made by ethylene-toluene alkylation with dehydrogenation of side chain; toluene-acetylene reaction; or benzene and propylene via cumene which is then dehydrogenated. Used to synthesize nitric acid, ammonium nimonomer for resins and synthetic fibers. Possible use as substitute for benzene derived styrene in synthetic rubber mfr.

AMMONIA—6, 7, 9, 13, 16, 18, 29, 46, 66, 68, 86, 100, 103, 127, 159, 167, 168, 190, 191, 199, 200, 208, 217, 225, 239, 245, 247, 274, 275, 283, 285, 306, 308, 310, 311, 312, 333, 338, 345, 360, 365, 385, 387, 392, 393, 407, 412

NH_3. Colorless gas or liq. BP —28.1°F (—33.4°C), MP —107.9°F (—77.7°C), SG (gas) 0.5971, SG (liq) 0.817 (—79°C). Made by reaction of hydrogen and nitrogen, with hydrogen from natural gas or from catalytic reforming. Used to synthesize nitric acid, ammonium nitrate, ammonium sulfate, hydrazine, sodium cyanide, etc.; as refrigerant, fertilizer or in fertilizer mfr.; in rubber vulcanization, petroleum refining, in production of synthetic fibers (e. g., rayon and nylon); and as resin-condensing agent.

AMMONIATING SOLUTIONS—310, 311, 312

Solutions containing ammonia, ammonium nitrate, and/or urea. Made by mixing aqua ammonia with ammonium nitrate and/or urea. Used to ammoniate superphosphate in the preparation of mixed fertilizer.

AMMONIUM NITRATE—29, 86, 100, 127, 190, 191, 199, 200, 245, 308, 310, 392

NH_4NO_3. Colorless or white solid. Decomposes at 410°F (210°C), MP 337.3°F (169.6°C), SG 1.725. Made from ammonia-nitric acid reaction in aqueous ammonium nitrate solution. Used as fertilizer to mfr. nitrous oxide; as nitrogen oxide absorbent; and to prod. insecticides.

AMMONIUM PHOSPHATE (Ammonium acid phosphate)—29, 30, 247

$NH_4H_2PO_4$. White powder or colorless-to-white crystals. SG 1.803. Made by ammonia-phosphoric acid reaction. Used in fertilizers, fireproofing.

AMMONIUM SULFATE—66, 141, 190, 247, 283, 349, 412

$(NH_4)_2SO_4$. White to brownish-gray crystals. MP 955.4°F (513°C) (decomp.), SG 1.77. Made from ammonia—conc. sulfuric acid reaction. Used as fertilizer; as fireproofing agent; in water treatment; and in prod. of textiles (viscose silk).

AMYL ACETATES (Banana oil, Pear oil, Amyl-acetic ester)—234, 278

$CH_3COOC_5H_{11}$. Colorless liq. Isomers range in BP from about 255.2°F (124°C at 740 mm. Hg) to 299.1°F (148.4°C at 737 mm), in MP from —95.4°F (—70.8°C) to —109.3°F (—78.5°C), SG 0.87-0.88. Made from amyl alcohols—acetic acid esterification, or fusel oil (principally isoamyl alcohol)—sodium acetate reaction. Used as solvent to mfr. nitrocellulose, rayons, celluloid and celluloid cements, lacquers, varnishes, waterproofing compounds.

AMYL ALCOHOLS (Butyl carbinols)—234, 278

$C_5H_{11}OH$. Colorless liq. Isomers range in BP from 215.6°F (102°C) to 280.4°F (138°C), in MP from 127.4°F (53°C) to —178.6°F (—117°C), SG from 0.809 to 0.824. Made from pentane chlorination followed by alkaline hydrolysis. Used to mfr. amyl acetate, lacquers, solvents, plasticizers, petroleum products; additives as solvents for oils, resins, sulfur, phosphorus, spirit varnishes, dyestuffs; in rubber vulcanization.

AMYL CHLORIDES (Chloropentane isomers)—234, 278

$C_5H_{11}Cl$. Straw-to-deep purple liq. BP 185-228°F (85-109°C), SG 0.88 (20°C), D 7.33 lb/gal. Made by mixed pentanes chlorination. Used to mfr. other amyl compounds, rubber cements; as solvent.

AMYL MERCAPTAN (Pentanethiol isomers, mixed)

$C_5H_{11}SH$. Colorless-to-light yellow liq. BP 219-266°F (104-130°C), SG 0.83-0.84, D 6.99 lb/gal. Made by mixing amyl bromide or amyl chloride with potassium hydrosulfide in alcohol. Used to mfr. organic sulfur compounds; as natural gas odorant.

AMYL NAPHTHALENES (Mixed isomers)—234, 278

$C_{10}H_7C_5H_{11}$. Yellow-to-brown liq. BP 550-692°F (288-367°C), SG 0.94-0.96 (20°C). Made by alkylating naphthalene with normal pentenes and amyl chloride. Used as high-boiling solvent, constant-temperature bath medium; to mfr. textile chemicals, resin plasticizers, asphaltic materials.

AMYL PHENOL, o-sec.—234, 278

$C_5H_{11}C_6H_4OH$. Straw-colored solid. BP 455-482°F (235-250°C), SG 0.955-0.971 (20/20°C), D 8.0 lb/gal. Made by phenol-n-pentenes alkylation. Used in paints as dispersing, mixing, antiskinning agent; to mfr. chemicals.

AMYL PHENOL, o-tert.

$(CH_3)_2C_2H_5CC_6H_4OH$. Pale yellow solid. BP 451-473°F (233-245°C), SG 0.96-0.97 (30° C), D 8.12 lb/gal. Made by phenol-mixed pentenes sulfuric-acid alkylation. Used in paint mfr. as dispersing, mixing, antiskinning agent; to mfr. chemicals.

AMYL PHENOL, p-tert.

$(CH_3)_2C_2H_5CC_6H_4OH$. White cryst. BP 509-513°F (265-267°C), MP 199°F (93°C), SG 0.91-0.94 (95°C). Made same as o-tert-amyl phenol, or phenol-tert-amyl alcohol reaction in sulfuric acid. Used as intermediate for oil-soluble phenol-formaldehyde resins, chemicals; as plasticizer.

ABBREVIATIONS

For the readers' information, abbreviations of physical properties used in the accompanying glossary are as follows: BP is boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

ANHYDRIDES (acid anhydrides)—52

RCOOCOR or $(RCO)_2$ (R is hydrocarbon group). E.g., acetic anhydride, maleic anhydride, and phthalic anhydride. Made generally by condensation of acid chloride with sodium salt of the acid, the acid chloride made from the sodium salt by reaction with phosphorus oxychloride. Used as chemical intermediates, esp. for acids.

ANTIKNOCK FLUIDS—118, 130, 131, 132, 395

Chemical mixtures containing tetraethyl lead, $Pb(C_2H_5)_4$, as the knock-inhibiting ingredient, and ethylene dichloride and/or ethylene dibromide as scavengers of the lead products formed on combustion. Made by treating lead-sodium alloy with ethyl chloride. Used as an antiknock additive in gasolines.

AROMATIC AND ALIPHATIC SOLVENTS—124, 178, 212, 213, 298, 302, 364, 366

Petroleum naphthas, either aromatic or aliphatic. Boiling generally somewhere in the gasoline range. From fractionation or extraction of virgin or refined crudes. Aromatic solvents available from reformed naphthas. Used as solvents.

AROMATIC DISTILLATE—181

Hydrocarbon fraction containing high proportion of aromatics, such as benzene, toluene, and the xylenes. From fractionation and/or extraction of high-aromatic-content crude fractions or reformed naphthas. Used as high-octane gasoline component, solvent; to mfr. detergents.

AROMATIC FRACTIONS, see Aromatic distillate—253

AROMATIC MIXTURES, see Aromatic distillate—97

AROMATIC TARS—122

Heavy viscous liquids, brown to black in color, with high aromatic and condensed aromatic hydrocarbon content. Made by destructive distillation, severe cracking, or coking of petroleum. Used as aromatic hydrocarbon source; to mfr. tar-based products.

BENZENE (Benzol)—14, 19, 95, 97, 102, 160, 231, 273, 290, 292, 315, 318, 333, 335, 366, 390, 403

C_6H_6. Colorless liq. BP 176.2°F (80.1°C), MP 42°F (5.56°C), SG 0.879 (20/4°C), D 7.32 lb/gal. Made by catalytic reforming of naphthalenes in petroleum naphthas. Used to mfr. phenol, styrene, nylon, detergents, aniline, maleic anhydride, phthalic anhydride, dephenyl, nitrobenzene, chlorobenzenes; as solvent, component of high-octane gasoline, varnishes, lacquers.

BENZENE HEXACHLORIDE (Hexachlorocyclohexane)—68, 108, 131

$C_6H_6Cl_6$. Tech. prod. (stereoisomers mixt.) white-to-yellowish solid. MP gamma isomer (lindane) 234°F (112°C). Made by photochemical benzene chlorination. Used as insecticide.

BENZENE SULFONYL CHLORIDE (Benzene sulfonic chloride)—105

$C_6H_5SO_2Cl$. Amber liq. BP 484.7°F (251.5°C), FP 58.1°F (14.5°C), SG 1.3842 (15°C). Made by sodium benzenesulfonate-phosphorus pentachloride reaction. Used as chemical intermediate, esp. to mfr. benzene sulfonamide plasticizer.

BISPHENOL A—288

$HOC_6H_4C(CH_3)_2C_6H_4OH$. White-to-brown flaky solid. BP 428°F (220°C), FP 302-307.4°F (150-153°C). Made by acetone-phenol condensation. Used as chemical intermediate; to mfr. epoxy resins, paints, glass-reinforced plastics, adhesives, oil-soluble phenolic resins.

BUTADIENE (1, 3-Butadiene, Vinylethylene)—10, 49, 101, 114, 115, 128, 137, 178, 211, 221, 231, 237, 238, 243, 284, 337, 406

$CH_2CHCHCH_2$. Colorless gas. BP 24.1°F (—4.4°C), FP —164°F (—108.9°C), SG 0.6211 (20°C). Made by n-butylenes or n-butane dehydrogenation, or ethyl alcohol dehydrogenation to acetaldehyde and subsequent reaction of acetaldehyde with excess alcohol, or from acetylene by Reppe process. Used to mfr. synthetic rubber (GR-S or Buna S with styrene, Butyl with isobutylene).

BUTANOL (n-Butyl alcohol, Propyl carbinol)—51, 57, 174

$CH_3CH_2CH_2CH_2OH$. Colorless liq. BP 243.9°F (117.7°C), FP —111.8°F (—79.9°C), SG 0.810

(20/4°C), D 6.75 lb/gal (20°C). Made by condensing acetaldehyde to aldol, dehydration of aldol to crotonaldehyde, and hydrogenation of latter to n-butanol; or by high pressure butane oxidation. Used as solvent; to mfr. esters, rayon, lacquers, cleaning solutions, paint removers, plastics, paints, varnishes, and enamels.

sec-BUTANOL (Butanol-2, sec-Butyl alcohol, Methylethylcarbinol)—129, 411

$CH_3CH_2CHOHCH_3$. Colorless liq. BP 211.1°F (99.5°C), FP —174.5°F (—114.7°C), SG 0.808 (20/4°C), D 6.74 lb/gal. Made by butylenes absorption in sulfuric acid, followed by hydrolysis of resulting butyl sulfates. Used to mfr. methyl ethyl ketone; as lacquer solvent and thinner.

tert-BUTANOL (Trimethyl carbinol)

$(CH_3)_3COH$. White crystals, BP 181°F (82.8°C), MP 77.9°F (25.5°C), SG 0.7887 (20/4°C). Made by isobutylene-sulfuric acid reaction followed by hydrolysis of resulting sulfate. Used as solvent, ethyl alcohol denaturant; to mfr. chemicals, resins; as lubricants stabilizer.

BUTYL ACETATE—57

$CH_3COOCH_2CH_2CH_2CH_3$. Colorless liq. BP 259.7°F (126.5°C), MP —106.2°F (—76.8°C), SG 0.882 (20°C), D 7.29 lb/gal. Made by n-butyl alcohol-acetic acid esterification. Used as solvent for natural and synthetic resins; to mfr. lacquers, pyroxylin solutions, plastics, safety glass.

sec-BUTYL ACETATE (2-Butanol acetate)—129

$CH_3COOCH(CH_3)CH_2CH_3$. Colorless liq. BP 234°F (112.2°C), SG 0.870 (20/4°C), D 7.18 lb/gal. Made by sec-butyl alcohol-acetic acid esterification. Used as nitrocellulose solvent to mfr. lacquers, thinners, celluloid products.

BUTYL-2, 4-DICHLOROPHENOXYACETATE—45

Weedkiller made by esterification of 2, 4, -D (2, 4-dichlorophenoxyacetic acid) with n-butyl alcohol. Used as herbicide.

BUTYLENE-1 (Butene-1, Ethyl ethylene)—160, 178, 332, 337, 339, 414

$CH_3CH_2CH=CH_2$. Colorless gas. BP —20.7°F (—6.3°C), MP —202°F (—130°C). Made by petroleum cracking or recovery from refinery gases. Used to mfr. alkylate gasolines, butadiene, chemicals.

BUTYLENE-2 (Butene-2, Dimethyl ethylene)

$CH_3CH=CHCH_3$. Colorless gas. BP cis form 38.7°F (3.7°C), trans form 33.6°F (0.88°C); MP both forms —196.6°F (—127°C). Made by petroleum cracking or recovery from refinery gases. Used to mfr. alkylate gasolines, butadiene, chemicals.

1, 3-BUTYLENE GLYCOL—57, 201

$HOCH_2CH_2CH(OH)CH_3$. Colorless liq. BP 405.5°F (207.5°C), SG 1.01 (20/20°C), D 8.4 lb/gal. Made by aldol from acetaldehyde reduction. Used to mfr. cellophane, textile fibers.

BUTYRALDEHYDE (n-Butyl aldehyde)—340

$CH_3CH_2CH_2CHO$. Colorless liq. BP 168.3°F (75.7°C), FP —146.2°F (—99°C), SG 0.805 (20/20°C), D 6.7 lb/gal. Made by n-butanol dehydrogenation or crotonaldehyde partial reduction. Used to mfr. rubber goods, synthetic resins, butyric acid.

BUTYRIC ACID (Butanoic acid, Ethyl acetic acid)—58

$CH_3CH_2CH_2COOH$. Colorless liq. BP 326.7°F (163.7°C), MP —17.8°F (—7.9°C), SG 0.9587 (20/4°C). Made by butyraldehyde (from n-butanol oxidation) oxidation. Used to mfr. cellulose butyrate and cellulose acetate butyrate plastics, plasticizers, lacquers.

CARBAMATE FUNGICIDES (Metallo-alkyl and metallo-alkenyl dithiocarbamates)—121

E.g., $(CH_3)_2NCSSNa$ (sodium dimethyldithiocarbamate). Solids more-or-less soluble in water. Made by amines-carbon disulfide reaction in presence of an alkali. Used to kill or prevent growth of fungi and/or their spores.

CARBON BISULFIDE (Carbon disulfide)—23, 325, 372

CS_2. Colorless liq. BP 115.3°F (46.3°C), MP —163.5°F (—108.6°C), SG 1.263 (20/4°C), D 10.48 lb/gal. Made by natural gas (methane)-sulfur reaction. Used to mfr. viscose rayon, carbon tetrachloride, varnishes, lacquers, paint and varnish removers, rubber products; as solvent for resins, rubber, waxes, sulfur, etc.

CARBON BLACKS—34, 35, 38, 39, 41, 42, 53, 69, 70, 71, 72, 74, 75, 76, 77, 80, 81, 82, 84, 89, 90, 91, 92, 176, 177, 194, 242, 249, 283, 293, 344, 350, 351, 352, 353, 354, 356, 357, 382

C. Black amorphous solid. BP 7,592°F (4,200°C), MP 6,332°F (3,500+°C), SG 1.8–2.1. Made by incomplete combustion or thermal decomposition of natural gas. Used in rubber compounding, inks, paints.

CARBON MONOXIDE

CO. Colorless gas. BP —310°F (—190°C), FP —326.2°F (—199°C), SG 0.967. Made by carbon dioxide-coke-oxygen reaction or incomplete combustion of natural gas with steam. Used as component of methanol synthesis gas, synthine (Fischer-Tropsch) reaction.

CARBON TETRACHLORIDE—11, 106, 110, 117, 328, 393

CCl_4. Colorless liq. BP 170.2°F (76.8°C), FP —9.4°F (—23.0°C), SG 1.595 (20/4°C), D 13.22 lb/gal. Made by carbon disulfide-chlorine reaction, or by methane chlorination and (as by-product) of higher hydrocarbons. Used as solvent, to mfr. Freon, chloroform, chlorinated organics, resins, lacquers.

CELLULOSE ACETATE (Acetyl cellulose)—383

$C_6H_7O(OOCH_3)_3$ or $C_6H_7O_2(OOCH_3)_3$ or $C_6H_7O_2(OOCH_3)_3$. White amorphous solid. MP 381–439°F (194–226°C), SG 1.329–1.365. Made by cellulose-acetic anhydride reaction followed by hydrolysis. Used to mfr. synthetic fibers, plastics, protective coatings.

CHLORAL—105

CHLORINATED BENZENE (Chlorobenzene, Chlorobenzol)—175

C_6H_5Cl. Colorless liq. BP 268.9°F (131.6°C), FP —49°F (—45°C), SG 1.105 (25/25°C), D 9.19 lb/gal. Made by benzene-chlorine reaction. Used as solvent; to mfr. phenol, aniline, picric acid, chloro- and nitrochlorobenzenes; as heat-transfer medium.

CHLORINATED PARAFFIN (Chlorocosane)—106

Light yellow-to-amber liq. SG 0.90–1.50. Made by melted paraffin-chlorine reaction. Used as dichloramine solvent; in textile mfr.

CHLORINATED SOLVENTS (Chlorohydrocarbon solvents)—375

Family of chlorinated hydrocarbons, including carbon tetrachloride, chloroform, ethylene dichloride, methyl chloride, methylene chloride, perchloroethylene, propylene dichloride, and trichloroethylene. Made, in general, by refinery gas chlorination. Used as solvents and extractants for oils, waxes.

CHLORINATED WAXES (Chlorinated paraffins)—175

Products range from pale yellow, viscous liquids to brittle, resinous solids as chlorine content increases from about 28 to 70%. Made by passing chlorine through molten paraffin waxes. Used as plasticizers, extreme-pressure lubricant additives; to mfr. corrosion-resistant paints.

CHLOROBENZENE, see Chlorinated benzene—68, 175

CHLOROFORM (Trichloromethane)—11, 109, 110, 117, 328

$CHCl_3$. Colorless liq. BP 142.2°F (61.2°C), FP —82.3°F (—63.5°C), SG 1.489 (20°C), D 12.4 lb/gal. Made by acetone-chlorinated lime ($CaOCl_2 \cdot H_2O$) reaction, or carbon tetrachloride reduction, or methane chlorination. Used as solvent; to mfr. aerosols, insecticides, vermicides, plastics; as fire extinguisher.

CHLOROHYDRINS—287

Generic name for polyhydroxy alcohols having one or more hydroxyl groups replaced by chlorine. E.g., $CH_2OHCHOHCH_2Cl$ (glyceryl alpha-chlorohydrin). Colorless liq. BP 416°F (213°C), FP —40°F (—40°C), SG 1.326 (18°C), D 11.012 lb/gal. Made by passing hydrogen chloride into glycerine containing acetic acid. Used as solvent for acetylcellulose, resins, cellulose acetate. Other chlorohydrins include ethylene chlorohydrin, $ClCH_2CH_2OH$; epichlorohydrin, CH_2OCHCH_2Cl; propylene chlorohydrin, $CH_3ClCHOHCH_3$; and dichlorohydrin, $CH_2ClCHOHCH_2Cl$, used as solvents.

CHLOROSULFONATED POLYETHYLENE—120

Partially chlorinated polyethylene into which sulfur-containing groups have been introduced; e.g., Hypalon 5-2, synthetic rubber. Hypalon made by ethylene chlorination to 25–30% chlorine content and reacting it with sulfur dioxide to introduce sulfonyl chloride groups into polymer chain. Used as polymer or elastomer, when cross-linked by curing with metal oxides.

CHLOROTOLUENES (ortho, meta, and para isomers)—175

$CH_3C_6H_4Cl$. Colorless liq. BP 318–324°F (159–162°C), FP 43.7 to —54.4°F (6.5 to —48°C), SG 1.065–1.078. Made by toluidine diazotization. Used as solvents, chemical intermediates.

CORROSION INHIBITORS—301, 304

CRESOLS (Cresylic acid, o-, m-, and p- cresol isomers)—32, 195, 198, 250, 251, 299, 302, 304, 316

$CH_3C_6H_4OH$. Yellowish liq. BP 383–401°F (195–205°C) MP 176°F (80°C), SG 1.044. Recovered from cracked naphthas and gas oils. Used to mfr. plastics, plasticizers, insecticides.

CUMENE (Isopropylbenzene)—170, 315, 380

$C_6H_5CH(CH_3)_2$. Colorless liq. BP 306.9°F (152.7°C), FP —140.8°F (—96°C), SG 0.8620, D 7.19 lb/gal. Made by benzene-propylene alkylation, or by benzene-isopropyl iodide interaction. Used as aviation gasoline blending agent; solvent; to mfr. lacquers, chemicals.

CYCLOHEXANE (Hexamethylene, Hexahydrobenzene)—178, 290

C_6H_{12}. Colorless liq. BP 177.3°F (80.7°C), FP 43.3°F (6.3°C), SG 0.779. Made by benzene hydrogenation, or naphtha catalytic reforming, or recovery from natural-gasoline and petroleum fractions. Used as solvent for oils, waxes, cellulose ethers, crude rubber, resins; to mfr. adipic acid, paint and varnish removers.

CYMENE ALCOHOL (Carvacrol, Isopropyl-o-cresol, 2-Hydroxy-p-cymene)—170

$CH_3C_6H_3OHCH(CH_3)_2$. Colorless liq. BP 458.6°F (237°C), FP 32°F (0°C), SG 0.976 (20/4°C). Made by p-cymene sulfonation, followed by alkali fusion. Used to mfr. fungicides.

DDT—105, 108

DECYL ALCOHOL (n-Decanol)—128

$CH_3(CH_2)_8CH_2OH$. Colorless liq. BP 451.2°F (232.9°C), FP 42.8°F (6°C), SG 0.829. Made by glacial acetic acid—capric aldehyde (capraldehyde) reaction. Used to mfr. surface-active agents, detergents, esters; as an antifoaming agent.

DEMULSIFYING AGENTS—301

Organic solvents, surface-active agents, or compounds antagonistic to the emulsifier in emulsions. E.g., hydrocarbon sulfonates. Used to render oil-water and water-oil emulsions unstable.

DICHLOROBENZENE (o-, m-, and p- isomers)—68

$C_6H_4Cl_2$. Colorless liq. (o- and m- isomers) or white crystals (p- isomer). Properties: ortho BP 352.4–357°F (178–180.5°C), FP about 4°F (—19°C), SG 1.305, D 10.9 lb/gal; meta BP 341.6°F (172°C), FP —11.2°F (—24°C), SG 1.288; para BP 344.7°F (173.7°C), MP 127.4°F (53°C), SG 1.458. Made by monochlorobenzene chlorination. Used as chemical intermediate, solvent, insecticide; to mfr. surface coatings, resins.

DICHLORODIFLUOROMETHANE ("Freon-12")—118

CCl_2F_2. Colorless gas. BP —20.2°F (—29°C), FP —252.4°F (—158°C), SG 1.326 (20/4°C). Made by carbon tetrachloride-hydrogen fluoride reaction. Used as refrigerant, aerosol propellant.

DICHLOROETHYLENE (Acetylene dichloride, cis and trans isomers)

$CHClCHCl$. Colorless liq. BP cis isomer 136–140°F (58–60°C), trans isomer 117–120°F (47–49°C); SG cis 1.282, trans 1.257. Made by acetylene partial chlorination. Used as solvent for oils, resins, waxes, rubber, shellac cellulose acetate; to mfr. plastics, lacquers, rubber, solvent mixtures.

DICHLOROETHYL ETHER—114, 117, 224

$ClCH_2CH_2OCH_2CH_2Cl$. Colorless liq. BP 353.3°F (178.5°C), FP −61.4°F (−51.9°C), SG 1.222, D 10.2 lb/gal. Made by ethyl ether chlorination. Used as solvent, to mfr. wetting agents, paints, varnishes, lacquers, finish removers; as chemical intermediate.

DICHLORO ISOPROPYL ETHER—117

$ClCH_2CH_2CHOCHCH_2CH_2Cl$. Colorless liq. BP 369.3°F (187.4°C), SG 1.1135 (20/20°C), D 9.3 lb/gal. Made from propylene and hypochlorous acid via mfr. and dehydration of propylene chlorohydrin. Used as solvent for greases, waxes; as extractant, paint remover.

DICHLOROPHENOL (Isomeric dichlorophenols)—105

$Cl_2C_6H_3OH$. Commercial product consists 80-90% of 2, 4-dichlorophenol. Properties of 2, 4-isomer: BP 410°F (210°C), MP 113°F (45°C), SG 1.383 (60/25°C). Made by chlorination—phanol. Used to mfr. 2, 4-D (2, 4-dichlorophenoxyacetic acid).

2, 4-DICHLOROPHENOXYACETIC ACID, DIMETHYLAMINE SALT (2, 4-D dimethylamine salt)—45, 105

$Cl_2C_6H_3OCH_2COOCH_3)_2NH_2$. Colorless liq. Made by 2, 4-dichlorophenoxyacetic acid (2, 4-D)-dimethylamine reaction, the 2, 4-D being from 2, 4-dichlorophenol-monochloroacetic acid reaction. Used as weed killer.

DICYCLOPENTADIENE—231

$C_{10}H_{12}$. Solid. BP 338°F (170°C), MP 92.5°F (33.6°C), SG 0.9766. Made by polymerization of cyclopentadiene (from cracked petroleum). Used as stable form for storage of cyclopentadiene (C_5H_6), which is raw material in resin mfr.

DIELDRIN (Hexachloro-epoxy-octahydro-dimethano-naphthalene)—286

White cryst. solid. MP 347-348.8°F (175-176°C). Used as insecticide.

DIETHANOLAMINE

$NH(CH_2CH_2OH)_2$. Faintly colored liq. BP 516.4°F (269.1°C), FP 82.4°F (28°C), SG 1.092 (30/20°C), D 9.1 lb/gal. Made by ethylene oxide-ammonia reaction. Used as softening and moistening agent; acid gas solvent (Girdler process), chemical intermediate.

DIETHYLBENZENE (o-, m-, and p- isomers)—114

$C_6H_4(C_2H_5)_2$. Colorless liq. BP o-, 362.1°F (183.48°C); m-, 357.9°F (181.13°C); p-, 362.8°F (183.78°C); FP o-, −23.5°F (−31.4°C); m-, −119.1°F (−83.92°C); p-, −45.8°F (−43.2°C); SG o-, 0.8805; m-, 0.8641; p-, 0.8619. By-product from ethylbenzene production (by ethylene-benzene condensation). Used as solvent, chemical intermediate.

DIETHYLENE GLYCOL—117, 181, 224, 375, 393

$CH_2OHCH_2OCH_2CH_2OH$. Colorless liq. BP 473°F (245°C), FP 17.6°F (−8°C), SG 1.1184, D 9.35 lb/gal. Made by ethylene oxide-water hydration, or direct ethylene oxide-ethylene glycol reaction. Used as solvent, antifreeze, natural-gas dehydrant; to mfr. plastics.

DIETHYLENE TRIAMINE

$NH_2CH_2CH_2NHCH_2CH_2NH_2$. Colorless liq. BP 404.8°F (207.1°C). By-product of ethylene diamine mfr. Used as lubricant additive.

DIMETHYL FORMAMIDE—121

$HCON(CH_3)_2$. Colorless liq. BP 307°F (152.8°C), SG 0.953-0.954. Made by dimethylamine acylation (with formic acid). Used as synthetic resins and acetylene solvent; potential use as solvent for polyacrylonitride.

DIMETHYL TEREPHTHALATE—169

$C_6H_4(COOCH_3)_2$. White flakes. BP 550.4°F (288°C), MP 285.1°F (140.6°C), SG 1.07 (150/25°C). Made by terephthalic acid-methyl alcohol esterification. Used to mfr. synthetic fibers (Dacron, Terylene); polyester plastic films (Mylar), plasticizers; in oil-modified alkyd resins.

DIPROPYLENE GLYCOL—57

$(CH_3CHOHCH_2)_2O$. Colorless liq. BP 449.2°F (231.8°C), SG 1.0252, D 8.5 lb/gal. Made by propylene oxide hydration or by propylene oxide-propylene glycol reaction. Used as solvent for nitrocellulose, shellac, cellulose acetate; in mfr. lacquers, surface coatings; as plasticizer.

DIVINYLBENZENE (Vinylstyrene, o-, m-, and p- isomers)—114, 187

$C_6H_4(CHCH_2)_2$. Colorless liq. Meta isomer: BP 391.1°F (199.5°C), FP −88.4°F (−66.9°C), SG 0.9289. Made by diethylbenzene (made from benzene and ethylene) dehydrogenation. Used to mfr. synthetic rubbers, drying oils, ion-exchange resins, plastics.

DODECYL BENZENE—398, 411

DODECYL MERCAPTAN (Lauryl mercaptan)

$C_{12}H_{25}SH$. Colorless-to-yellow liq. BP 392-455°F (200-235°C), SG 0.85. Made by dodecene-hydrogen sulfide reaction; or treating dodecene with thioacetic acid, converting resulting ester by alcoholysis to dodecyl mercaptan. Used to mfr. synthetic rubber (polymerization controller), plastics, insecticides, fungicides.

DRY ICE AND LIQUID CARBON DIOXIDE—29, 191, 306, 313, 348

CO_2. White solid or colorless liq. BP −108.8°F (−78.2°C), FP −68.8°F (−56°C at 5 atm.), SG liq. 1.057, SG solid 1.56. From natural gas or petroleum hydrocarbon combustion. Used as chemical intermediate, as dehydrating agent, to produce inert atmospheres and vacuums.

ENDRIN—286

Hexachloro - epoxy - octahydro - endo - endo - dimethanonaphthalene. An insecticide isomeric with dieldrin and generically similar to aldrin and dieldrin. Used as insecticide.

EPON RESINS—288

Trade name of epoxy resins produced by Shell Chemical Corp. Made by epichlorohydrin-bisphenol A. condensation. Used to mfr. surface coatings, chemical-resistant enamels.

ESTERS—52, 54, 55, 383

RCOOR1 (R and R1 are hydrocarbon radicals). Colorless liquids to colorless crystalline solids, depending on chain length. Made by alcohol-organic acid reaction. Used as solvents and plasticizers; to mfr. plastics, surface coatings.

ETHANOL (Ethyl alcohol)—51, 128, 174, 209, 340

CH_3CH_2OH. Colorless liq. BP 172.9°F (78.3°C), FP −169.6°F (−112°C), SG 0.7905, D 6.578 lb/gal. Made by direct catalytic hydration of ethylene; or via ethyl sulfate intermediate; or by carbon monoxide-hydrogen catalytic synthesis (methanol-synthesis by-product; also Fischer-Tropsch). Used as antifreeze; to mfr. acetaldehyde, ethyl acetate, ether, chloroform, iodoform, butadiene; as solvent and extraction medium.

ETHANOLAMINES (See Mono-, Di-, and Tri-)—8, 114, 181, 224

ETHERS—52, 209

ROR1 (R and R1 are hydrocarbon radicals). Generally pleasant-smelling liquids with BP < corresponding alcohols, SG<1.00. Made by alcohol dehydration. Used as extractants and solvents.

ETHYLBENZENE—114, 189, 231

$C_6H_5C_2H_5$. Colorless liq. BP 277.2°F (136.2°C), FP −139.0°F (−94.98°C), SG 0.867, D 7.21 lb/gal. Made by benzene-ethyl chloride reaction. Used as intermediate for styrene; as solvent and diluent.

ETHYL CELLULOSE (Cellulose ether)—114

White granular solid. SG 1.07-1.18. Properties vary depending on extent of replacement of hydroxy radicals. Made from alkali cellulose and ethyl chloride or ethyl sulfate, or from cellulose and ethyl alcohol in presence of dehydrating agents. Used to mfr. adhesives, lacquers, plastics.

ETHYL CHLORIDE—114, 115, 118, 131, 132, 209

CH_3CH_2Cl. Colorless gas. BP 54.1°F (12.27°C), MP −216.9°F (−138.3°C), SG 0.917 (6/6°C). Made by addition of hydrogen chloride to ethylene, or from ethyl alcohol-hydrogen chloride reaction. Used to mfr. tetraethyl lead, ethyl cellulose; as refrigerant; as solvent for phosphorus, sulfur, resins, oils, waxes.

ETHYLENE (**ETHENE**)—128, 129, 164, 185, 209, 231, 248, 270, 393, 405

CH_2CH_2. Colorless gas. BP −152.5°F (−102.5°C), MP −272.2°F (−169°C), SG 0.978. Made by petroleum cracking, or recovery from refinery gases, or passing ethyl alcohol over dehydration catalyst. Used as intermediate for ethanol, ethylene dibromide, ethylene dichloride, styrene; to mfr. polyethylene plastics.

ETHYLENE AMINES (See Ethylene diamine, Piperazine, Diethylene triamine, Triethylene tetramine, Tetraethylene pentamine)—50, 114

ETHYLENE DIAMINE—114, 224

$NH_2CH_2CH_2NH_2$. Colorless liq. BP 242.6°F (117°C), SG 0.892. Made by corresponding dinitrile reduction, or by ammonia-acetylene (or ethylene) reaction. Used as solvent for oils, waxes; to mfr. sequestering agents.

ETHYLENE DIBROMIDE (Ethylene bromide, Dibromoethane)—114, 131, 133

CH_2BrCH_2Br. Colorless liq. BP 268°F (131°C), FP 48.4°F (9.1°C), SG 2.17-2.18, D 18.1 lb/gal. Made by ethylene-bromine reaction. Used in tetraethyl lead antiknock fluids; solvent for oils, waxes, plastics; to mfr. waterproofing compounds, celluloid, organic chemicals.

ETHYLENE DICHLORIDE (Dichloroethane, Ethylene chloride)—107, 114, 115, 132, 181, 224, 375

CH_2ClCH_2Cl. Colorless liq. BP 182.3°F (83.5°C), FP −31.9°F (−35.5°C), SG 1.2554 (20/40°C), D 10.4 lb/gal. Made by ethylene-chlorine reaction. Used in tetraethyl lead antiknock fluids; solvent for oils, waxes, rubber, plastics; to mfr. lacquers, paint removers, wetting agents, ethylene diamine.

ETHYLENE GLYCOL—8, 47, 48, 49, 114, 115, 140, 181, 224, 375, 391, 393

CH_2OHCH_2OH. Colorless liq. BP 387°F (197.2°C), FP 1.4°F (−17°C), SG 1.1155, D 9.31 lb/gal. Made by oxidation of ethylene to ethylene oxide, followed by hydration of the oxide; or by mfr. of ethylene chlorohydrin (from ethylene and chlorine), followed by hydrolysis. Used as antifreeze, solvent, chemical intermediate; to mfr. brake fluids, lacquers, resins, synthetic fibers.

ETHYLENE GLYCOL DIACETATE—57

$(CH_3OOCCH_2)_2$. Colorless liq. BP 359.6°F (182°C), SG 1.11. Made by ethylene oxide-acetic acid (or acetic anhydride) reaction. Used as solvent for resins, cellulose derivatives.

ETHYLENE GLYCOL MONO-OLEATE—45

$C_{17}H_{33}COOCH_2CH_2OH$. Colorless liq. BP 374-392°F (190-200 at reduced pressure), FP 33.8°F (1°C). Made by ethylene glycol-oleic acid reaction. Used as surface-active, emulsifying, stabilizing, dispersing, wetting, foaming, and suspending agents.

ETHYLENE OXIDE—8, 47, 49, 114, 117, 140, 181, 224, 374, 391, 393

CH_2CH_2O. Colorless gas. BP 55-57°F (13-14°C), FP −167.8°F (−111°C), SG 0.882, D 7.2 lb/gal (20°C). Made by oxidation of ethylene, or by ethylene chlorohydrin—alkali reaction. Used as intermediate for ethylene glycol.

ETHYL ETHER (Ether, diethyl ether, Sulfuric ether)—128

$(CH_3CH_2)_2O$. Colorless gas. BP 94.1°F (34.5°C), FP −177.2°F (−116.2°C), SG 0.7147, D 6 lb/gal (20°C). Made by sulfuric acid dehydration of ethyl alcohol, or by-product in mfr. of ethyl alcohol from ethylene. Used as chemical intermediate, solvent, refrigerant, alcohol denaturant.

2-ETHYLHEXANOL (2-Ethylhexyl alcohol, Octyl alcohol)—51, 340

$CH_3(CH_2)_3CH_2CH(C_2H_5)CH_2OH$. Colorless liq. BP 362.3°F (183.5°C), SG 0.83, D 6.9 lb/gal. Made by 1-ethylhexaldehyde (made from n-butraldehyde) reduction. Used as defoaming and wetting agent, chemical intermediate; to mfr. plasticizers and detergents.

ETHYL MERCAPTAN (Ethyl sulfhydrate)—210, 316, 349

CH_3CH_2SH. Colorless liq. BP 97.9°F (36.2°C), FP −185.8°F (−121°C), SG 0.839. Made by calcium ethyl sulfate-hydrogen sulfide (in alkali solution) reaction. Used as gas odorant.

ABBREVIATIONS

For the readers' information, abbreviations of physical properties used in the accompanying glossary are as follows: BP is boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

PETROCHEMICALS
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EXPLOSIVES—362

Substances capable of undergoing very rapid, self-propagating decomposition. E.g., trinitrotoluene, $CH_3C_6H_2(NO_2)_3$, yellow solid, MP 177.6°F (80.9°C), SG 1.654; made by nitration of toluene with mixed acid. Used as high explosive for military and industry. Other petroleum-derived explosives include ammonium nitrate, nitroglycerin, ethylenedinitramine, and glycol dinitrate (used to mfr. dynamite).

FORMALDEHYDE—7, 25, 26, 57, 168, 258, 262, 265, 266, 309, 370, 378, 409

HCHO (usually in H_2O). Colorless gas (or liq. in aqueous sol.). Properties: gas: BP —2.2°F (—19°C), MP —180.4°F (—118°C), SG 0.815 (—20°C). Properties, 37% sol.: BP 101°C), SG 1.112. Made by natural gas oxidation, or by methanol-air reaction. Used to mfr. formic acid, urea, hexamethylene-tetramine, acetaldehyde, paraformaldehyde, pentaerythritol, plastics, synthetic fibers, adhesives.

GAS ODORANTS—315, 316

Gaseous or liquid organic sulfur compounds. Often, but not always, mercaptans such as ethyl mercaptan (tradename "Captan") or amyl mercaptan (tradename "Pentaform"). "Gal odorant" is a special, sulfurous hydrocarbon fraction of petroleum. Used to odorize natural gas so that leaks can be detected.

GLYCERINE (Glycerol)—117, 287, 288

$CH_2OHCHOHCH_2OH$. Colorless-to-yellow liq. BP 554°F (290°C), FP 64.2°F (17.9°C), SG 1.260, D 10.5 lb/gal. Made from propylene via prod. of allyl alcohol, its chlorination and hydrolysis with alkali solution. Used to mfr. alkyd resins, protective coatings, emulsifiers, cellophane, synthetic fibers; as solvent, antifreeze, plasticizer.

GLYCOLS (See Ethylene glycol, Diethylene glycol, Triethylene glycol, Propylene glycol, butylene glycol)—50, 51, 52, 224

GLYCOL ETHERS—224

$ROCH_2(CH_2OH)_n$ (R is a hydrocarbon radical). Made by treating ethylene oxide with excess alcohol (e.g., ethanol), or by glycols-alkyl sulfates reaction. Used as solvents and chemical intermediates.

HEXACHLOROBENZENE—105

C_6Cl_6. White needles. BP 618.8°F (326°C), MP 444.2°F (229°C). Made by hexyl iodide-iodine chloride reaction. Used as chemical intermediate.

HEXACHLOROBUTADIENE—108

$Cl\text{-}CCCl\text{-}CCl\text{-}CCl_2$. Colorless liq. BP 410-428°F (210-220°C), FP —2 to —8°F (—19 to —22°C), SG 1.675 (15.5°C), D 13.97 lb/gal (15.5°C). Made by butadiene chlorination. Used as solvent, noninflammable heat-transfer liquid, transformer and hydraulic fluid, extractant (for C_4 and higher hydrocarbons).

HEXACHLOROCYCLOPENTADIENE (tradename "C-56")—175

C_5Cl_6. Yellow-to-amber liq. BP 456.8°F (236°C), FP 28.4°F (—2°C), SG 1.715 (15°C), D 14.3 lb/gal (15.5°C). Made by cyclopentadiene chlorination. Used as chemical intermediate.

HEXACHLOROETHANE (Carbon trichloride, Perchloroethane)—108

CCl_3CCl_3. Colorless cryst. solid. MP 365°F (185°C); sublimes at 185°C; SG 2.091. Made by higher hydrocarbon chlorinolysis (with carbon tetrachloride by-product); or by trichloroethane or tetrachloroethylene chlorination. Used as chemical intermediate, solvent, camphor substitute in mfr. of celluloid, rubber accelerator.

HEXAMETHYLENE DIAMINE—122, 309, 394

$NH_2(CH_2)_6NH_2$. Colorless solid. BP 384.8°F (196° C), MP 102-104°F (39-40°C). Made by adiponitrile-hydrogen-ammonia reaction. Used to mfr. nylon.

HYDRAZINE—225

H_2NNH_2. Colorless liq. BP 234.5°F (113.5°C), FP 35.6°F (2°C), SG 1.011. Made by hydrazine hydrate (from oxidation of ammonia or urea by hypochlorite) dehydration. Used as rocket fuel, solvent, reducing agent, chemical intermediate.

HYDROCYANIC ACID, See Hydrogen cyanide—13

HYDROGEN—125, 214, 332, 414

H_2. Colorless gas. BP —423°F (—252.8°C), FP —434.4°F (—259.1°C), SG 0.06948 (air=1). Made from natural-gas by reaction with steam or thermal decomposition, or by-product from naphtha reforming. Used to mfr. ammonia, methanol; in unsaturated hydrocarbons hydrogenation.

HYDROGEN CHLORIDE (Hydrochloric acid)—106, 107, 328, 393

HCl. Colorless gas. BP —117.6°F (—83.1°C), FP —167.8°F (—111°C), D 1.6392 gms/liter (0°C). Made by hydrogen-chlorine reaction, or by-products from hydrocarbon chlorination. Used to mfr. vinyl chloride, alkyl chlorides, paints.

HYDROGEN CYANIDE (Hydrocyanic acid, Prussic acid)—119, 203, 272

HCN. Colorless liq. BP 78.1°F (25.6°C), FP 8.1°F (—13.3°C), SG 0.6970. Made by methane-ammonia-air reaction or treating cyanide salts with sulfuric acid. Used as fumigant; to mfr. acetone cyanhydrin, ethylene cyanhydrin, acrylic resins.

HYDROGEN PEROXIDE—287

H_2O_2. Colorless liq. BP 316.4°F (158°C), FP 28.4°F (—2°C), SG 1.46. Made by oxidation of sulfuric acid or sulfates to persulfuric acid or persalts, followed by hydrolysis to peroxide. Used as rocket fuel, oxidizing agent, polymerization catalyst; to mfr. synthetic rubber.

HYDROGEN SULFIDE—23, 270, 271

H_2S. Colorless gas. BP —76.4°F (—60.2°C), FP —118.8°F (—83.8°C), SG 1.1895. Recovered from sour natural gas and petroleum, or formed during refining of sulfur-containing oils. Used as chemical intermediate, purification agent, analytical reagent.

INSECTICIDES, synthetic organic (see also specific materials)—366

E.g., $(ClC_6H_4)_2CHCCl_3$ (DDT). MP 227.3-228.2°F (108.5-109°C), SG 1.556. From chlorobenzene-chloral condensation. Halogenated insecticides include methoxychlor, $CH_3O(C_6H_4)CHCCl_3(C_6H_4OCH_3)$, benzene hexachloride, chlordane (octachloromethano-tetrahydroindan), aldrin and dieldrin. Other synthetic insecticides include organic phosphorus compounds (e.g., tetraethyl pyrophosphate), organic nitrogen compounds (e.g., dinitro-o-cresol), organic sulfur compounds (e.g., aliphatic thiocyanates).

ISOBUTANOL (Isobutyl alcohol, Isopropyl carbinol, 2-methylpropanol-1)—57, 174, 340

$(CH_3)_2CHCH_2OH$. Colorless liq. BP 226.2°F (107.9°C), FP —162.4°F (—108°C), SG 0.798 (25/4°C), D 6.65 lb/gal. By-product of synthetic methanol process, or from oxidation of butane. Used as solvent; in hydraulic-brake fluids; to mfr. isobutyl acetate, isobutyl aldehyde, paint removers.

ISOBUTYL ACETATE—57

$(CH_3)_2CHCH_2OOCCH_3$. Colorless liq. BP 244.4°F (118°C), FP —146°F (—98.9°C), SG 0.871 (20/4°C), D 7.26 lb/gal. Made by isobutyl alcohol-acetic acid reaction. Used as nitrocellulose solvent; to mfr. protective coatings.

ISOBUTYLENE (Isobutene, 2-methylpropene)—128, 129, 339, 405

$(CH_3)_2CCH_2$. Colorless gas. BP 19.6°F (—6.9°C), MP —218.2°F (—139°C). Recovered from refinery gases. Used to mfr. alkylate and polymer gasolines, butyl rubber; intermediate for alkyl halides.

ISOBUTYRALDEHYDE (Isobutyl aldehyde)—340

$(CH_3)_2CHCHO$. Colorless liq. BP 145-147°F (63-64°C), SG 0.797. Made by isobutanol oxidation. Used as chemical intermediate.

ISOBUTYRONITRILE (Isopropyl cyanide, 2-Methypropanenitrile)

$(CH_3)_2CHCN$. Colorless liq. BP 224.6°F (107°C). Made by isopropanol-hydrogen cyanide reaction; by isobutylene-ammonia reaction; or dehydrogenation or oxidation of isobutylamine. Used as chemical intermediate.

ISOCYANATES—201

RNCO (R is hydrocarbon radical). E.g., $C_{18}H_{37}NCO$, octadecyl isocyanate. BP 302-356°F (150-180°C), FP 59-64.4°F (15-18°C), SG 0.86. Isocyanates made by phosgene ($COCl_2$)-amine salt reaction. Used to mfr. plastics, adhesives, foamed resins, synthetic fibers and rubber (Vulcollan).

ISOOCTYL ALCOHOL—128, 164, 317

$C_8H_{17}CH_2OH$. Colorless liq. (isomeric mixt.). Properties roughly similar to 2-ethylhexanol (which see). Made from C_7 hydrocarbons by Oxo process (hydrogen-carbon monoxide reaction). Used as solvent, emulsifier, anti-foaming agent; to mfr. plasticizers, nonionic detergents, synthetic drying oils, hydraulic fluids, lubricants.

ISOPHTHALIC ACID (Benzene-meta-dicarboxylic acid)—316

$C_6H_4(COOH)_2$. White cryst. solid. MP 662°F (350°C). Made by meta-xylene oxidation. Use (potential) to mfr. alkyd and polyester resins, plasticizers, surface coatings.

ISOPRENE—128, 231

$CH_2CiCH_3CHCH_2$. Colorless liq. BP 93.4°F (34.08°C), FP —230.8°F (—146°C), SG 0.6808 (20/4°C). Made by isopentene or isopentane dehydrogenation, or high-temperature thermal cracking of petroleum. Used to mfr. butyl and other synthetic rubbers, plastics, chemicals.

ISOPROPANOL (Isopropyl alcohol, Dimethyl carbinol)—48, 128, 129, 174, 377, 411

$(CH_3)_2CHOH$. Colorless liq. BP 180.3°F (82.4°C), FP —126.2°F (—97.9°C), SG 0.7863, D 6.55 lb/gal. Made by propylene-sulfuric acid reaction, followed by hydrolysis of the sulfate. Used to mfr. lacquers, acetone; as antifreeze, solvent, extractant, dehydrating agent.

ISOPROPANOL AMINES (Mixed mono-, di-, and tri-)—114

E.g., $CH_3CHOHCH_2NH_2$. Colorless liq. BP 113°F (45°C) at 5 mm Hg, SG 0.981. Made by propylene oxide-ammonia reaction. Used as chemical intermediates; in soap mfr.

ISOPROPYL ACETATE—129

$CH_3COOCH(CH_3)_2$. Colorless liq. BP 192.9°F (89.4°C), FP —100.1°F (—73.4°C), SG 0.877 (15.5°C), D 7.17 lb/gal. Made by isopropyl alcohol-acetic acid reaction. Used as solvent; to mfr. surface coatings, plastics, lacquers.

ISOPROPYL BENZENE, see Cumene—114, 231

ISOPROPYL CHLORIDE—114

$(CH_3)_2CHCl$. Colorless liq. BP 97.7°F (36.5°C), SG 0.860. Made by isopropanol-hydrogen chloride reaction. Used as chemical intermediate.

ISOPROPYL -2,4-DICHLOROPHENOXYACETATE—45

Weedkiller made by 2,4-D (2,4-dichlorophenoxyacetic acid)-isopropanol reaction. Used as herbicide.

ISOPROPYL ETHER (Diisopropyl ether)—128

$(CH_3)_2CHOCH(CH_3)_2$. Colorless liq. BP 153.5°F (67.5°C), MP —176.4°F (—99°C), SG 0.733 (15.5/4°C), D 6.05 lb/gal (60°F). Made by isopropyl sulfate (from propylene sulfonation)-isopropyl alcohol reaction. Used as solvent and blending agent in high-octane gasolines.

KETONES (see also specific ones)—52, 383

RCOR' (R and R' are hydrocarbon radicals). E.g., see methyl ethyl ketone. Aliphatic ketones made by secondary alcohol oxidation or dehydrogenation, or by acetylene hydration. Aromatic ketones made by organic acid halide-aromatic hydrocarbon condensation. Used as solvents, to mfr. plastics.

LATEX—110, 114, 117, 136, 143, 393

Emulsion containing about 60% water, 35% natural or synthetic rubber, and 5% emulsifying agents and stabilizers (natural or added). Made by emulsifying natural or synthetic rubber in water. Used to mfr. rubber products, latex paints.

LINDANE (Gamma-benzene hexachloride)—108, 131

$C_6H_6Cl_6$. White solid. MP 233.6°F (112°C). Made by photochemical chlorination of benzene. Used as insecticide.

MALEIC ANHYDRIDE—264

$(CHCO)_2O$. White needles or flakes. BP 391.5°F (199.7°C), MP 127.4°F (53°C), SG 0.934 (20/4°C). Made by benzene oxidation. Used as chemical intermediate; to mfr. plastics.

METALLIC NAPHTHENATES—54, 55, 218, 219, 220, 316

Metallic salts of naphthenic acids. Made by lead salt-aqueous sodium naphthenate solution (obtained by caustic scrubbing of kerosene and

petroleum gas-oil fractions) reaction. Used to mfr. greases, paint driers, cutting oils, plastics.

METHANOL (Methyl alcohol, wood alcohol)—7, 57, 58, 86, 122, 168, 174, 203, 310, 370

CH_3OH. Colorless liq. BP 148.5°F (64.7°C), FP —144°F (—97.9°C), SG 0.792 (20/4°C), D 6.59 lb/gal. Synthesized from carbon monoxide and hydrogen, or from partial oxidation of natural gas. Used as antifreeze, ethyl alcohol denaturant, solvent; to mfr. formaldehyde, dimethylamine, dimethylaniline.

METHIONINE—120

$CH_3SCH_2CH_2CH(NH_2)COOH$. Solid. MP 538-541°F (281-283°C). Made from acrolein and methanol mercaptan or monothioethylene glycol. Used as growth accessory; in pharmaceuticals.

METHYLAL (Dimethoxymethane, Formal)—57

$CH_2(OCH_3)_2$. Colorless liq. BP 108.4°F (42.3°C), FP —156.6°F (—104.8°C), SG 0.86 (20/4°C). Made by formaldehyde polymerization. Used as solvent, chemical intermediate, special fuel; to mfr. protective coatings.

METHYL AMINE (Monomethylamine)—121

CH_3NH_2. Colorless gas. BP 22-21°F (—5.5 to —6.0°C), MP —139.9°F (—95.5°C), SG 0.699 (18.8/5°C). Made by methanol-ammonia reaction. Used as solvent; to mfr. chemicals.

METHYL BUTYL KETONE (Propylacetone)—174

$CH_3COC_4H_9$. Colorless liq. Isomeric mixt. ranging in BP from 223-261°F (106-127°C); SG n-form, 0.830. Made by dehydrogenation or oxidation of C_6 alcohols, or acetic acid-butyl carbinol reaction. Used as solvent, chemical intermediate.

METHYL CELLULOSE—114

White solid. Made by alkali cellulose-methyl chloride (or methyl alcohol) reaction and dehydrating agents. Used as adhesive; dispersing, thickening, emulsifying, and sizing agent.

METHYL CHLORIDE (Chloromethane)—11, 109, 110, 117

CH_3Cl. Colorless gas. BP —10.7°F (—23.7°C), MP —143.7°F (—97.6°C), SG 0.92, D 7.68 lb/gal. Made by methanol-hydrochloric acid reaction in presence of sulfuric acid. Used as refrigerant, methylating agent, extractant, solvent.

METHYL CHLOROFORM (1,1,1 Trichloroethane)—117

CH_3CCl_3. Colorless liq. BP 167°F (75°C), SG 1.325. Made by asymmetric dichloroethylene-hydrogen chloride reaction. Used in medicine.

METHYL ETHYL KETONE—58, 129, 174, 411

$CH_3COCH_2CH_3$. Colorless liq. BP 175.3°F (79.6°C), FP —123.3°F (—86.4°C), SG 0.805 (20/4°C), D 6.71 lb/gal. Made by sec-butyl alcohol dehydrogenation, or modified Fischer-Tropsch process from carbon monoxide and hydrogen. Used as solvent, chemical intermediate; to mfr. lacquers, celluloid, varnish removers.

METHYL MERCAPTAN (Methanethiol)— 14, 210, 349

CH_3SH. Colorless gas. BP 45.7°F (7.6°C), FP —189.4°F (—123.1°C). Made by methanol-hydrogen sulfide reaction, or recovery from petroleum naphthas. Used in synthesis of methionine; potentially to mfr. plastics, jet-fuel additives, fungicides.

METHYL PROPYL KETONE (Ethyl acetone)—174

$CH_3COCH_2CH_2CH_3$. Colorless liq. BP 215.1°F (101.7°C), SG 0.809. Made by amyl alcohol dehydrogenation. Used as solvent, chemical intermediate.

METHYL VINYL PYRIDINE (2-Methyl-5 vinylpyridine)—247

$CH_3C_5H_3NCHCH_2$. Liquid. BP 354.2°F (179°C), MP (—12°C), SG 0.964 (20/4°C). Made by 2-methyl-5-ethyl pyridine dehydrogenation (in turn made by paraldehyde-aqueous ammonia reaction). Used as copolymer with butadiene and styrene to mfr. synthetic rubbers; with acrylonitrile to improve synthetic fiber dyeability; to mfr. ion-exchange resins.

METHYL STYRENE—13, 170

$C_6H_5C(CH_3)CH_2$. Colorless liq. BP 329.7°F (165.38°C), FP —9.8°F (—23.21°C), SG 0.9062 (25°C). Made from benzene and propylene via alkylation to cumene, followed by dehydrogenation. Used as monomer to make plastics, synthetic rubbers, and other high polymers.

METHYLENE CHLORIDE (Methylene dichloride) —11, 109, 110, 117, 328

CH_2Cl_2. Colorless liq. BP 107.6°F (42°C), MP —142.6°F (—97°C), SG 1.335 (15/4°C), D 11.07 lb/gal. Made by methyl chloride chlorination, or by chlorine-methane reaction. Used as solvent, refrigerant, fire-extinguishing compound, extractant, aerosol component, chemical intermediate.

MITICIDES—105

MONOCHLOROBENZENE, see Chlorinated benzene

MONOETHANOLAMINE

$NH_2CH_2CH_2OH$. Colorless liq. BP 338.9°F (170.5°C), SG 1.0179, D 8.47 lb/gal. Made by ethylene oxide-ammonia reaction, or by nitration and reduction of propane. Used as solvent (Girdler nat.-gas purif. process); to mfr. detergents, (2-nitraminoethyl nitrate), vulcanization accelerator.

MORPHOLINE—181

$O(CH_2CH_2)_2NH$. Colorless liq. BP 263.5°F (128.6°C), FP 26.4°F (—3.1°C), SG 1.0017, D 8.3 lb/gal. Made by diethanolamine dehydration, or by di-2-chloroethyl ether-ammonia reaction. Used as solvent, corrosion inhibitor, emulsifying agent, chemical intermediate; to mfr. rubber chemicals.

MURIATIC ACID, see Hydrogen Chloride—105, 108, 109

NAPHTHAS (Cleaners naphtha, Stoddard solvent, Reformer charge stock)—403

Liquid petroleum hydrocarbon fractions generally boiling within gasoline range. Recovered by distillation of crude oil (to get virgin naphtha) or cracked fractions. Used as solvent, dry-cleaning agent, charge stock to reforming units to mfr. high-octane gasoline.

NAPHTHALENE—231, 251

$C_{10}H_8$. White flakes or powder. BP 424.2°F (217.9°C), MP 176.4°F (80.2°C), SG 1.152. Distilled from crude and cracked petroleum. Used to mfr. phthalic anhydride, β-naphthol; as antioxidant, resin solvent; to mfr. insecticides, fungicides, surface-active agents, celluloid, lacquers, varnishes.

NAPHTHENIC ACIDS—129, 216, 333, 339

Dark-colored liquids. BP 392-572°F (200-300°C). Chiefly alkyl cyclopentane acetic acids. Recovered from naphthenic crude oils. Used to mfr. metallo-organic salts for paint driers, additives for extreme-pressure lubricants, grease additives; as chemical intermediate, solvent.

NITRIC ACID (Aqua fortis)—29, 127, 190, 191, 200, 217, 225, 245, 306, 308, 310, 311, 312, 316

HNO_3. Colorless-to-yellowish liq. BP 186.8°F (86°C), FP —42.3°F (—41.3°C), SG 1.530. Made by ammonia oxidation. Used as chemical intermediate, rocket-fuel component; to mfr. celluloid, fertilizers.

NITROGEN SOLUTIONS—46, 100, 245, 274, 306, 308, 338

Mixture of ammonium nitrate (about 60 parts) and 50% aqua ammonia (about 40 parts). Used to neutralize superphosphate to mfr. fertilizer.

NITROGENOUS FERTILIZERS—190, 217, 360 385, 404

Fertilizers containing substantial amounts of nitrogen in form available to plants, e.g., ammonium nitrate, ammonium sulfate, ammonium phosphate. Used as plant nutrient.

NITROPARAFFINS—85, 86

RNO_2, where R is an alkyl radical. E.g., CH_3NO_2 (nitromethane), $CH_3CH_2NO_2$ (nitroethane), etc. BP nitromethane 213.8°F (101°C), SG 1.139; BP nitroethane 237.2°F (114°C), SG 1.052. Made by paraffin hydrocarbons-nitric acid reaction. Used as solvents for nitrocellulose, cellulose acetate, other cellulosic materials, resins, waxes; as chemical intermediates.

NONYL PHENOL—181

$C_9H_{19}C_6H_4OH$. Straw-colored liq. BP 563-579°F (295-304°C), SG 0.968. Made by phenol-nonylene alkylation. Used as chemical intermediate; to mfr. synthetic detergents and resins.

NYLON (Polyhexamethylene adipamide)—62

$(—CO(CH_2)_4CONH(CH_2)_6NH—)_n$. Cream-white solid. Made by "nylon salt" (made from equimolar proportions of hexamethylene diamine and adipic acid) dehydration. Used as synthetic fiber, molding powder, sheeting.

OIL TREATING CHEMICALS—94, 367, 368

Chemical compounds or mixtures of chemicals used to treat petroleum for purpose of purification; e.g., desalting.

OLEFIN CONCENTRATE (C_7) (Mixed heptenes) —319

C_7H_{14}. Colorless liq. BP 199.4-209.3°F (93-98.5°C), FP about —182°F (—119°C), SG about 0.70. Made by dehydrogenation of C_7 paraffin hydrocarbons or separated from C_7 fraction of cracked oils. Used as chemical intermediate, particularly in Oxo process olefin-carbon monoxide-hydrogen reaction to make alcohols, aldehydes, etc.)

ORTHOXYLENE (1, 2-dimethyl benzene)—316

$C_6H_4(CH_3)_2$. Colorless liq. BP 291.9°F (144.4°C), FP —13.9°F (—25.5°C), SG 0.880 (20/4°C), D 7.36 lb/gal. Made by catalytic reforming of naphthenic petroleum fractions (i.e., dehydrogenation of dimethylcyclohexane). Used to mfr. phthalic anhydride; see also Xylenes, Mixed.

OXIDES (Olefin oxides)—52

RO, (R an unsaturated hydrocarbin radical) e.g., CH_2CH_2O (ethylene oxide). Made by olefin oxidation, or by olefin chlorination to chlorohydrins, followed by alkali treatment of chlorohydrins. Used to mfr. glycols, synthetic fibers, plastics, detergents.

PARA-CRESOL (p-Cresylic acid)—170

$CH_3C_6H_4OH$. Crystalline solid. BP 395.6°F (202°C), MP 96.8°F (36°C), SG 1.035 (20/4°C). Recovered from cracked naphthas and gas oils. Used as chemical intermediate; in mfr. antioxidants.

PARAFFIN SOLVENT, see Chlorinated paraffins —107

PARAFORMALDEHYDE (Formaldehyde polymer) —57

$HO(CH_2O)_nH$, l_n ranges from about 8 to 50. White powder. MP 248-320°F (120-160°C). Made by evaporating aqueous formaldehyde solutions. Used to mfr. resins, glues.

PARA-TERTIARY-BUTYLBENZOIC ACID (p-TBBA)—282

$p\text{-}(CH_3)_3CC_6H_4COOH$. Made by oxidation of p-tert-butyl toluene (prod. by alkylation of toluene with isobutylene). Used in alkyd-resin paints; potentially to mfr. plasticizers, corrosion inhibitors, insecticides, thickening agents for paints and greases.

PARAXYLENE (1, 4-dimethylbenzene) — 178, 241, 302, 315, 316

$C_6H_4(CH_3)_2$. Colorless liq. or crystals. BP 281.3°F (138.5°C), FP 55.8°F (13.2°C), SG 0.861 (20/4°C). Made by catalytic reforming of naphthenic petroleum fractions (contg. dimethylcyclohexane). Used as chemical intermediate; to mfr. synthetic fibers and plasticizers.

PENTACHLOROPHENOL—266, 267

PENTAERYTHRITOL—168, 173, 258, 370, 383, 409

$C(CH_2OH)_4$. Colorless cryst. or white powder. BP 528.8°F (276°C at 30 mm Hg), MP 500°F (260°C) SG 1.399 (25/4°C). Made by acetaldehyde-formaldehyde reaction in alkali solution. Used as chemical intermediate; to mfr. plastics, plasticizers, drying oils, insecticides.

PERCHLOROETHYLENE (Tetrachloroethylene)— 67, 107, 110, 117, 118, 328, 393

CCl_2CCl_2. Colorless liq. BP 244-252°F (118-122°C), FP —8.32°F (—22.4°C), SG 1.60-1.615, D 13.46 lb/gal. Made by acetylene-chlorine

ABBREVIATIONS

For the readers' information, abbreviations of physical properties used in the accompanying glossary are as follows: BP is boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

reaction. Used to mfr. trichloroethylene; as solvent.

PETROLEUM POLYMERS—14, 366

Basically $(-CH_2-)_n$. n may vary widely. Products may range from light liquids, such as polymer gasoline, to solid resins or plastics, such as polyethylene. Made, in general, by polymerization of olefins, or by copolymerization of olefins and aromatics (e.g., the diolefin, butadiene, with the aromatic, styrene, to form GR-S synthetic rubber). Used as chemical intermediates, engine fuels, plastics, synthetic rubbers.

PETROLEUM RESINS—14, 212, 213, 232, 250, 300, 366, 378

High polymers produced by polymerization of olefins or aromatics (e.g., polyethylene, polystyrene). Used as plastics.

PETROLEUM WAXES (Paraffin wax, Ceresin)—371

$CH_3(CH_2)_{n}CH_3$. White waxy solid. MP 108-140°F (42-60°C). SG 0.880-0.915. Recovered chilling and filtering paraffinic crude oils. Used to mfr. candles, waxed coatings, waterproof coatings, lubricants.

PHENOL (Carbolic acid)—2, 32, 170, 202, 250, 251, 258, 316, 377

C_6H_5OH. White crystals. BP 358.5°F (181.4°C), MP 107-109°F (42-43°C). SG 1.071 (25/4°C). Made by benzene-sulfuric acid-caustic soda reaction (benzene sulfonate process), or by chlorobenzene-sodium carbonate (or sodium hydroxide) reaction, or benzene-hydrochloric acid-air reaction (Raschig process). Used as chemical intermediate; to mfr. phenolic resins, 2, 4-D weed killer, synthetic detergents; as solvent in petroleum refining.

PHENOL-CRESOL BLENDS—198

Mixtures of phenol, C_6H_5OH, and cresol, $CH_3C_6H_4OH$. Properties depend on proportions of each component (and of cresol isomers). Made or recovered from petroleum in same manner as components. Used as solvent, chemical intermediate.

PHTHALIC ANHYDRIDE—201, 259, 263, 316

$C_6H_4(CO)_2O$. White flakes or needles. BP 544.1°F (284.5°C), MP 267.4°F (130.8°C). SG 1.527 (4°C). Made by oxidation of naphthalene or orthoxylene. Used to mfr. synthetic resins, plasticizers, insect repellant; as chemical intermediate.

PIPERAZINE (Diethylenediamine)

$NH(CH_2)_2 \cdot (CH_2)_2NH$. Colorless crystals. BP 293°F (145°C), MP 219-224°F (104-107°C). Made by ammonia-ethylene bromide (or ethylene chloride) reaction. Used in medicine.

PIPERYLENE—231

$CH_3CHCHCHCH_2$. Colorless liq. BP 109.4°F (43°C). Recovered from cracked petroleum fractions or made by n-pentane dehydrogenation. Used as chemical intermediate.

PLASTICIZERS—14, 51, 52, 60, 317

POLYAMINES—224

$(RNH)_n$. (R is olefin radical). See ethylene diamine, diethylene triamine, triethylene tetramine, tetraethylene pentamine. Other polyamines include propylene diamine, tetramethylene diamine, pentamethylene diamine, and hexamethylene diamine. Used to mfr. detergents, softening agents, rubber accelerators, resins, synthetic fibers; as solvents.

POLYBUTADIENE

$(CH_2CHCHCH_2)_n$. Liq. to solid, depending on chain length. E.g., $C_6H_5CHCH_2$, 3-vinylcyclohexene, made by butadiene dimerization, while octahydrobiphenyl results from its trimerization. Used in chemicals mfr.

POLYBUTADIENE-ACRYLONITRILE TYPE ACYCLIC ELASTOMERS—(Buna N synthetic rubber)—134, 172

Synthetic rubber made by copolymerization of 60 to 80 parts of butadiene with 20 to 40 parts of acrylonitrile. Used for oil-resistant synthetic rubber having good low-temperature flexibility. (see Synthetic rubber.)

POLYBUTADIENE-STYRENE TYPE ACYCLIC ELASTOMERS—(GR-S synthetic rubber)—134

Synthetic rubber made by copolymerization of about 75 parts butadiene with about 25 parts styrene. Used as natural rubber replacement in many uses. (see Synthetic rubber.)

POLYBUTENES—102, 229, 316, 317

$(-CH_2CH_2CH_2CH_2-)_n$. Range from tacky viscous liquids to rubbery solids. Made by polymerization of butylenes (usually isobutenes). Used to mfr. adhesives, coatings, plasticizers, tank linings, gaskets.

POLYESTERS—143, 201

POLYETHYLENE—10, 31, 47, 49, 50, 51, 52, 59, 117, 122, 157, 171, 185, 186, 187, 203, 209, 247, 314, 340, 386, 391

$(C_2H_4)_n$. Ranges from colorless liquid to white solid depending on molecule size. Made by ethylene polymerization. Used as lubricants for low molecular weight polymers; as plastics for high polymers.

POLYGLYCOLS—114, 117, 224

$HO(CH_2CH_2O)_n(CH_2CH_2O)H$. Liquids at molecular weights up to 1,000; solids at higher molecular weights. Made by passing ethylene oxide into diethylene glycol or preformed polyglycol in presence of a sodium compound catalyst. Liquid products used as plasticizers and dispersants, lubricants; solid products as softening agents, lubricants.

POLYGLYCOL ETHERS—114

$RO(CH_2CH_2O)_nCH_2CH_2OH$. (R is hydrocarbon group). Made by polyglycols-alcohols reaction. Used as solvents, chemical intermediates.

POLYISOBUTYLENE, see Polybutenes—129

POLYSTYRENE—111, 112, 115, 116, 187, 393, 402

$(C_6H_5CHCH_2)_n$. Colorless solid. Made by styrene polymerization. Used as plastic for molding, extruding, or casting; to mfr. plastic products, surface finishes; in laminating fabrics.

POLYVINYL CHLORIDE—114, 121, 142, 396

$(H_2CCHCl)_n$. White powder. Made of vinyl chloride polymerization. Used as plastic and plastic component (e.g., with polyvinyl acetate or Buna N); in copolymers (e.g., with acrylonitrile to give Vinyon N, a synthetic fiber).

POLYVINYL CHLORIDE RESIN—230

$(H_2CCHCl)_n$. White powder. Brittle at 32°F (0°C). Made by vinyl chloride polymerization. Used as plastic; to mfr. plastic sheets and films; (used less than interpolymers or copolymers containing polyvinyl chloride because of brittleness and fabrication problems).

POLYVINYLIDENE CHLORIDE—114

$(CCl_2CH_2)_n$. Crystalline solid of high tensile strength and chemical inertness. Made by vinylidine chloride polymerization. Used to mfr. plastic pipes and fittings, window screening, high tensile strength extruded products.

PROPANOL, normal (n-Propyl alcohol)—57, 174

$CH_3CH_2CH_2OH$. Colorless liq. BP 208°F (97.8°C), FP —197°F (—127°C), SG 0.804 (20/4°C), D 6.7 lb/gal. Made by aliphatic hydrocarbons (such as butane) oxidation. Used as chemical intermediate, solvent.

PROPIONIC ACID (Methylacetic acid)—58, 174

CH_3CH_2COOH. Colorless liq. BP 285.3°F (140.7°C), FP —7.6°F (—22°C), SG 0.987. Made by chromic acid oxidation of n-propanol, or by Fischer-Tropsch process from carbon monoxide and hydrogen. Used to mfr. propionates, emulsifying agents, solvents for cellulosics.

PROPIONALDEHYDE—174

CH_3CH_2CHO. Colorless liq. BP 119.8°F (48.8°C), SG 0.807. Made (together with allyl alcohol) by propylene oxide isomerization. Used as chemical intermediate; to mfr. plastics (e.g., polyvinyl acetals), rubber chemicals.

PROPYL ACETATE, normal

$C_3H_7OOCCH_3$. Colorless liq. BP 205-216°F (96-102°C), SG 0.897, D 7.36 lb/gal. Made by n-propanol-acetic acid reaction in presence of sulfuric acid. Used as solvent for cellulosics, natural and synthetic resins; to mfr. plastics, lacquers.

PROPYLENE (Propene)—10, 162

CH_3CHCH_2. Colorless gas. BP —52.6°F (—47°C), FP —301.4°F (—185.2°C), SG 1.46 (air=1) at 0°C. Recovered from cracked refinery gases, or made by propane dehydrogenation. Used as chemical intermediate, e.g., for allyl alcohol and isopropanol; major potential use to mfr. polypropylene plastics.

PROPYLENE DICHLORIDE (1,2-Dichloropropane)—114, 117

$CH_3CHClCH_2Cl$. Colorless liq. BP 205.3°F (96.3°C), FP —112°F (—80°C), SG 1.1583, D 9.6 lb/gal. Made by propylene-chlorine reaction. Used as solvent for waxes, oils, resins, cellulose esters and ethers.

PROPYLENE GLYCOL (1,2-Dihydroxypropane)—57, 114, 117, 383

$CH_3CHOHCH_2OH$. Colorless liq. BP 370.8°F (188.2°C), SG 1.0381, D 8.6 lb/gal. Made by propylene oxide hydration. Used as solvent, for oils, waxes, resins; to mfr. hydraulic fluids, alkyl resins, plasticizers.

PROPYLENE OXIDE (Epoxypropane)—57, 114, 117, 383

CH_3CHCH_2O. Colorless liq. BP 93°F (33.9°C), FP —155.9°F (—104.4°C), SG 0.8304, D 6.9 lb/gal. Made from propylene by the chlorohydrin process (similar to mfr. of ethylene oxide and glycol). Used as chemical intermediate (e.g., propylene glycols), solvent for nitrocellulose, cellulose acetate, gums; as insecticide.

PROPYLENE TETRAMER (Dodecene)—95, 128, 229, 269, 302, 332, 333, 334, 335, 339, 398

$CH_3CH(CH_3)_9CH_3$. Colorless liq. BP 415.4°F (213°C), FP —28.5°F (—33.6°C), SG 0.7600. Made by propylene polymerization. Used as chemical intermediate; in synthetic detergents mfr.

PROPYLENE TRIMER (Nonylene, Nonene)—128, 229, 269, 333, 339, 398

$CH_3(CH_3)_6CHCH_2$. Colorless liq. BP 302°F (150°C), SG 0.7433. Made by propylene polymerization. Used as chemical intermediate.

RUBBER BASE PAINT (Latex paints)—143

Paints using latex (emulsion of natural or synthetic rubber with water) base. Synthetic latex bases may be butadiene-styrene, polystyrene, polyvinyl acetate, vinyl chloride-vinylidene chloride, or polyacrylic polymers. Used as water-thinned paints.

RUST PREVENTIVES—12

SODIUM CARBOXYMETHYL CELLULOSE—375

$[C_6H_7O_2(OH)_2OCH_2COONa]_n$, approx. formula. White granular powder. Stable without discoloration up to 347°F (175°C). Made by alkali cellulose-monochloracetic acid reaction to get carboxymethyl cellulose, followed by reaction with sodium hydroxide to convert to sodium compound. Used as film-forming agent, thickener, stabilizer, adhesive, emulsifying agent.

SODIUM CRESYLATE (Sodium carbolate)—195, 317, 318

Water-soluble sodium salts of cresylic acid (unseparated cresol isomers) or aqueous solutions of such salts. Made by treating cresylic acid with aqueous sodium hydroxide. Used as source of crude cresols.

SODIUM NITRATE—225

$NaNO_3$. Colorless crystals. MP 586.4°F (308°C), SG 2.267. Made by nitric acid-sodium hydroxide reaction. Used as oxidizing agent, fertilizer, refrigerant.

SODIUM SULFHYDRATE (Sodium hydrosulfide)—23, 198

$NaSH \cdot 2H_2O$. Colorless needles or lemon-colored flakes. MP about 131°F (55°C). Made by treating calcium sulfide with sodium bisulfate. Used to mfr. chemicals; in desulfurizing viscose rayon.

SODIUM SULFIDE—198

Na_2S. Yellow-to-red solid. MP 1,688°F (920°C), SG 1.856. Made by passing hydrogen sulfide (from sour natural gas) through sodium hydroxide solution. Used to mfr. chemicals, rayon, rubber products; as sulfiding agent.

SODIUM SULFITE—305

Na_2SO_3. White crystals or powder. SG 2.6334; decomposes instead of melting. Made by sul-

fur dioxide-sodium carbonate reaction. Used to mfr. chemicals; as chemical reducing agent, and in treating of latex.

SOLVENTS (general)—58, 235, 254, 280, 282, 288, 303, 304, 370, 383

STYRENE (Vinylbenzene)—22, 51, 114, 117, 137, 232, 284

$C_6H_5CHCH_2$. Colorless-to-yellowish liquid. BP 293.4°F (145.2°C), FP −23.1°F (−30.6°C), SG 0.903 (20/4°C), D 7.55 lb/gal. Made by benzene-ethylene alkylation, followed by dehydrogenation of resulting ethylbenzene. Used as monomer to mfr. plastics and synthetic rubber (e.g., polystyrene, GR-S rubber).

STYRENE MONOMER, see Styrene—102, 138, 187, 203, 393, 405

STYRENE OXIDE (1,2-Epoxyethylbenzene)—117

$C_6H_5C_2H_3O$. Colorless-to-straw colored liq. Made by addition of hypochlorous acid to styrene, followed by treating resulting chlorohydrin with aqueous alkali; or by direct epoxidation of styrene with peroxybenzoic or peroxyacetic acids. Used as chemical intermediate; to mfr. resins, water-resistant varnishes.

STYRENE RESINS—143, 156, 196, 197, 363

Clear-and-colorless to opaque-and-colored resins and plastics composed of polystyrene alone or polystyrene and other polymer formers. E.g., high-impact polystyrenes are mixtures or copolymers with synthetic rubber; chemically resistant polystyrene is a copolymer with acrylonitrile.

SULFONATED ALKYL BENZENES (Alkyl benzenesulfonates)—255, 256

E.g., $C_{12}H_{25}C_6H_4SO_3Na$ (dodecylbenzene sodium sulfonate). Made by benzene-aliphatic petroleum hydrocarbons (propylene tetramer for dodecylbenzene) alkylation, followed by sulfonation of resulting alkyl benzene. Used as synthetic detergents.

SULFONATES (Petroleum sulfonates)—27, 33, 94, 98, 207, 215, 233, 289, 301, 304, 307, 316, 333, 339

Petroleum hydrocarbons into which the highly polar $-SO_3OH$ group has been introduced. Classification as to aliphatic, alicyclic, aromatic, or heterocyclic depends upon type of group to which the polar group is attached. Made by sulfonating petroleum hydrocarbons. Used as surface-active, wetting, dispersing, and emulsifying agents; synthetic detergents; chemical intermediates.

SULFUR—20, 23, 82, 126, 139, 162, 163, 164, 165, 166, 182, 205, 222, 223, 240, 244, 246, 252, 276, 277, 292, 294, 295, 296, 302, 304, 318, 321, 322, 323, 324, 333, 342, 346, 347, 348, 349, 369, 373, 379, 389, 400, 408, 410

S. Amorphous or solid yellow element. BP 832.3°F (444.6°C), MP about 248°F (120°C), SG amorphous form 1.9556; solid form 2.046. Made by conversion to sulfur of the sulfur compounds removed from sour natural gas and petroleum. Used to mfr. sulfuric acid; to vulcanize rubber; to mfr. oil-resistant synthetic rubbers, plastics, fertilizers, paper.

SULFURIC ACID (Oil of vitriol)—3, 4, 16, 190, 202, 217, 326, 327, 329, 330, 331, 345, 360, 399

H_2SO_4. Colorless-to-brown liq. BP 599-640°F (315-338°C), MP 50°F (10°C), SG 1.834. Made by oxidation of sulfur dioxide to sulfur trioxide, followed by hydration of the trioxide with water (contact process); or by reaction of nitric oxide (from ammonia) with sulfur dioxide and water in lead chambers to form sulfuric acid and nitrous oxide (chamber process). Used to mfr. chemicals, fertilizers, paints, pigments, rayon and cellulose film.

SYNTHETIC DETERGENTS—5, 16, 17, 96, 375

Liquid or solid materials capable of dissolving oily materials and dispersing or emulsifying them in water. Petroleum sulfonates, sulfates, salts, and amides are among the more common synthetic detergents. See sulfonated alkyl benzenes and Sulfonates.

SYNTHETIC LUBES—207

Hydrocarbons, polyglycols, esters, amines, imines, amides, silicones, fluorinated organic compounds. Made from petroleum hydrocarbons, natural gas, or refinery gases. Used as oils and greases where requirements of heat and chemical resistance, viscosity characteristics, service life, etc., can be met better than by petroleum oils.

SYNTHETIC RESINS (Plastics, synthetic)—128, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267

Solid organic substances which can be molded or shaped by flow in some stage of mfr. E.g., cellulosics, phenolics, urea and melamine resins, polyethylene, polystyrene, polyvinyl chloride and polyvinyl esters, alkyd resins, coumarone-indene resins. Made generally by polymerization of a monomer (e.g., ethylene) or by copolymerization of monomers (e.g., vinyl chloride-vinyl acetate); or by condensation reactions (e.g., phenol-formaldehyde). Used in molding, extruding, drawing, casting, or blowing plastic products.

SYNTHETIC RUBBER—15, 101, 128, 135, 136, 144, 149, 150, 152, 153, 154, 155, 178, 211, 243, 284, 359, 361, 405

High polymers or copolymers possessing many physical properties of natural rubber, including elasticity and ability to be vulcanized. Made by copolymerization of butadiene and styrene (GR-S), or of butadiene and acrylonitrile (Buna N- type); or by polymerization of isobutylene with a small amount of isoprene (Butyl rubber); by reaction of sodium polysulfide with an organic dichloride (Thiokol rubber); by polymerization of dimethyl-siloxane (silicone rubber). Used as replacement for synthetic rubber in many uses; also where special properties, such as chemical resistance, are required.

SYNTHETIC RUBBER (nitrile), see Polybutadiene-acrylonitrile type—147, 148, 156, 363

TERT-DODECYLMERCAPTAN, see Dodecyl mercaptan—234

TERYLENE (Dacron)—388

British name for polyester fiber made from ethylene glycol and terephthalic acid. Used to mfr. synthetic textiles.

TETRAETHYL PYROPHOSPHATE (TEPP)—45

$(C_2H_5)_4P_2O_7$. White-to-amber liq. Made by ethanol-phosphorus oxychloride reaction, or by triethyl phosphate-phosphorus oxychloride reaction. Used to mfr. insecticides; as a rodenticide.

TETRAETHYLENE GLYCOL—117

$HO(C_2H_4O)_3C_2H_4OH$. Colorless liq. BP 621.1°F (327.3°C), FP 20.8°F (−6.2°C), SG 1.1248, D 9.4 lb/gal. Made by ethylene oxide condensation. Used as nitrocellulose solvent; plasticizer; to mfr. lacquers; potential as resin intermediate, heat-transfer medium.

TETRAHYDROFURFURYL -2,4,5-TRICHLOROPHENOXYACETATE—45, 105

Weedkiller from 2,4,5-T (2,4,5-trichlorophenoxyacetic acid)-tetrahydrofurfuryl alcohol esterification. Used when needing low volatility, high activity herbicide.

THIOPHENE—180

C_4H_4S. Colorless liq. BP 183.2°F (84°C), FP −37.3°F (−38.5°C), SG 1.0644 (20/4°C). Recovered from petroleum by desulfurization processes. Used as chemical intermediate.

TOLUENE (Toluol)—14, 95, 102, 117, 160, 178, 253, 273, 290, 291, 292, 302, 315, 318, 333, 335, 366, 390, 403

$C_6H_5CH_3$. Colorless liq. BP 231.4°F (110.8°C), FP −139.2°F (−95.1°C), SG 0.866 (20/4°C), D 7.21 lb/gal. Made by hydroforming petroleum fractions containing methyl cyclohexane. Used as high-octane gasoline blending agent; chemical intermediate; as solvent.

TRICHLOROETHYLENE—67, 117, 118, 393

$ClCHCCl_2$. Colorless liq. BP 189°F (87.2°C), FP −99.4°F (−73°C), SG 1.466, D 12.2 lb/gal. Made by acetylene-chlorine reaction followed by reaction of the resulting tetrachloroethane with calcium hydroxide. Used as degreasing and dry cleaning solvent, extractant for fats and oils, heat-exchange liquid.

TRICHLOROMETHYLMERCAPTO-4-CYCLOHEXENE-1,2-DICARBOXIMIDE—45

TRICHLOROMONOFLUOROMETHANE ("Freon-11")—118

CCl_3F. Colorless gas or very volatile liq. BP 74.7°F (23.7°C), FP −126.4°F (−88.0°C). Made by carbon tetrachloride-hydrofluoric acid reaction. Used as refrigerant, aerosol propellant.

TRICHLORPHENOL (2,4,5- and 2,4,6-trichlorophenol)—105

$C_6H_3Cl_3OH$. Flaky solid either yellow (2,4,6-isomer) or gray (2,4,5-isomer). Properties of 2,4,5-isomer: BP 485.6°F (252°C), MP 142-146°F (61-63°C), SG 1.678 (25/4°C). Properties of 2,4,6-isomer: BP 478-480°F (248-9°C), FP 142°F (61°C), SG 1.675 (25/4°C). Made by phenol chlorination. Used as fungicides.

TRICRESYL PHOSPHATE (TCP)—60, 206

$(CH_3C_6H_4O)_3PO$. Colorless-to-yellow liq. BP 523-527°F (273-275°C at 17 mm Hg), FP −4°F (−20°C), SG 1.165. Made by cresol-phosphorus oxychloride reaction. Used as plasticizer, lubricant additive, surface-ignition and plug-fouling depressant in gasoline.

TRIDECYL ALCOHOL (Tridecanol)—128

$C_{13}H_{27}OH$. Colorless liq. or solid. BP 311-313°F (155-156°C at 15 mm Hg), FP 87°F (30.6°C). Made from C_{13} olefins by Oxo process (carbon monoxide-hydrogen reaction). Used as chemical intermediate, solvent.

TRIETHANOLAMINE

$N(CH_2CH_2OH)_3$. Pale yellow liq. BP 680°F (360°C), FP 70.2°F (21.2°C), SG 1.12, D 9.4 lb/gal. Made by ethylene oxide-ammonia reaction. Used as solvent, corrosion inhibitor, dispersing agent in rubber; to mfr. emulsifying agents, plastics.

TRIETHYLENE GLYCOL—117, 224, 393

$HO(C_2H_4O)_2C_2H_4OH$. Colorless liq. BP 549.3°F (287.4°C), FP 19°F (−7.2°C), SG 1.1254, D 9.4 lb/gal. Made by ethylene oxide condensation. Used as solvent, chemical intermediate; to mfr. resins, lacquers; to dehydrate natural gas.

TRIOXANE (Metaformaldehyde)—57

$(CH_2O)_3$. White crystals. BP 239°F (115°C), MP 143.6°F (62°C). Made by formaldehyde distillation. Used as chemical intermediate, odorless and nonluminous fuel.

UREA—6, 7, 66, 103, 159, 285, 306, 308, 345

NH_2CONH_2. White crystals or powder. Decomposes before boiling. MP 270.9°F (132.7°C), SG 1.335 (20/4°C). Made by ammonia-carbon dioxide reaction. Used as chemical intermediate, fertilizer; to mfr. plastics, adhesives, fire-resistant paints.

VINYL ACETATE—58

$CH_3COOCHCH_2$. Colorless liq. BP 161.2-163.4°F (71.8-73°C), FP −148.4°F (−100.2°C), SG 0.9335-0.9345, D 7.70 lb/gal. Made by acetylene-acetic acid reaction. Used as monomer to mfr. vinyl plastics.

VINYL CHLORIDE (Chloroethylene)—107, 117, 203

CH_2CHCl. Colorless gas (or liq. under pressure). BP 7°F (−13.9°C), FP −255.5°F (−159.7°C), SG 0.9121, D 7.6 lb/gal. Made by acetylene-hydrogen chloride reaction, or by catalytic cracking of ethylene dichloride. Used as monomer to mfr. vinyl plastics, refrigerant.

VINYL RESINS—50, 52, 230

Plastics made by polymerization or copolymerization of vinyl compounds, such as vinyl chloride and vinyl acetate. Used in molding, casting, drawing, extruding, or blowing plastic products.

VINYL TOLUENE, see Methyl styrene—114

VINYLIDENE CHLORIDE (asymmetric Dichloroethylene)—117

CCl_2CH_2. Colorless liq. BP 98.6°F (37°C). Made by treating 1,1,2-trichloroethane with caustic soda. Used as polymerization monomer to mfr. polyvinylidene chloride and interpolymers with vinyl chloride (Saran, Velon).

VINYLPYRIDINE TYPE ACYCLIC ELASTOMERS—143

Copolymers made from butadiene and 2-vinylpyridine. Properties are superior in some respects to GR-S rubber, esp. in flexing-hysteresis characteristics.

WETTING AGENTS—52

XYLENES, Mixed (o-, m-, and p-Dimethylbenzenes)—14, 32, 102, 160, 178, 253, 290, 291, 302, 316, 318, 333, 335, 366, 390, 403

$C_6H_4(CH_3)_2$. Colorless liq. BP 279-284.9°F (137.2-140.5°C), SG 0.865-0.870, D 7.2 lb/gal. Made by catalytic reforming of naphthenic petroleum fractions (contg. dimethylcyclohexane). Used as chemical intermediate, solvent; to mfr. xylidines (aviation-gasoline blending agents), lacquers, enamels.

PETROLEUM PROCESSING brought a tape recorder to the last regional meeting of the Western Petroleum Refiners Ass'n in El Dorado, Ark., and came away with enough valuable tips to provide a series of articles on solving processing problems. Source of information is the panel of authorities that took on all questions at an all-day question-and-answer session during the meeting. This is the fourth part of the series. For list of panel members, see top of p. 144.

Eleven technologists and a recorder help you solve

Coking Problems

. . . including gas oil carbon, optimum residue, proper timing, pressure effects

? In delayed coking units what are the techniques employed to significantly reduce carbon residue of coker gas oil?

Ferguson

Ferguson: I think probably the best technique to reduce carbon residue is to charge your coker feed directly to the bottom of your fractionator This has several other advantages besides cleaning up the coker gas oil. Another method is to install a preflash vessel—a refluxed flash vessel—in which you draw a net make of fuel oil, or heavier oil, which would also tend to clean up your coker gas oil. I'm sure that some of you have better methods than that, and I would appreciate hearing about them.

? Is a Conradson carbon of about 0.15% considered to be good on a 30 gravity coker gas oil from East Texas crude?

Ferguson: That's a relative question. I think it is high myself, because I've seen coker gas oils from similar crude running down in the order of 0.03 up to 0.1. It looks a little high to me, it may not be. It's not too high to run in somebody's cat cracker.

? What are the practical difficulties that might be expected when operating coking cycles on 18-hour intervals rather than the generally standard 24 hours in delayed coking operations?

Ferguson: I think that probably your greatest disadvantage is going to be in scheduling—trying to schedule your crews for turn-arounds on these chambers. Then, too, 18 hours is cutting it pretty short on your complete cycle of taking it off the line, cooling, decoking, buttoning it up, heating it up and getting it ready to go back on the line. I think something on the order of up to 20 hours is required. So you're cutting it pretty short on an 18-hour interval, coupled with difficulties of scheduling.

? What are the effects on yields of lowering the pressure on the coke drums for a conventional coking operation? Is there a lower coke yield?

Ferguson: Lower pressure yields less coke, and more gas oil. Also, I have heard some discussion on whether you get a lower volatility on your coke. It stands to reason that at a lower pressure, and the same temperature, you ought to get a lower volatility on your coke.

(Continued on following page)

? What has been the experience when using radioactive cobalt level indicators in coke drums and what are the benefits of their installation?

Ferguson: I think that they do show the foam level on top of your bed, and they are good flow rate schedulers. You can check them periodically to tell whether you are filling your drum too fast, or you are going to have to take it off line too early, or whether you are laggging behind. It indicates how to control your feed rate. I think I'll let Oscar Fuchs tell us more about that.

Fuchs

Fuchs: I don't believe that I can elaborate too much on what you said about the use of radioactive indicators. We do have them installed in our units—and they have been in service for about two months. We're getting a good indication of the foam level, but, to date, I don't believe we could say that they've given us a gain in the coke drum capacity. That was one of the purposes of their installation—that we might be assured of always filling our coke drums to the maximum level, thereby getting maximum capacity on the unit. But, we have hopes that it will be done.

We use just one cobalt source, and two detectors on each drum, and we have one rate meter that is tied in with both drums—that is, one drum at a time. As the coke level rises, it blocks out the signal to the lower detector and, as it gets higher, ultimately blocks out the signal on the highest detector. In that way we are able to measure the rate of coke filling. But right now, I don't believe I could say that we fill our drums higher than their design. They were designed for 420, and we are running them about 400-410 right now.

Wheeler: Bob Maddocks, do you want to tell us a little about low pressure operation?

Maddocks

Maddocks: Rather than take up the time for a dissertation here, it would be more interesting if Mr. Eppard, who was previously employed by Blaw-Knox and who has a great deal of experience and background in low pressure coking, would tell us why Sunray at Duncan has converted its high pressure unit into a low pressure operation.

? Chairman: What is the low pressure coking story at Duncan?

Eppard (D-X Sunray): I worked on the design of a low pressure coking unit built at Tyler, Texas, for McMurrey, which is running with coke drum pressures of 10 psi, and on a 2000-b/d charge to the coking heater. They are using about 4000 lb/hr of steam. They haven't had any excessive trouble with carry-over or foaming in their unit.

The coking unit at Duncan was operating at about 35 psi on the coke drums. They lowered the coke drum pressure to about 25 psi by just lowering the receiver pressure, and at the same the chimney temperature at the gas oil draw was increased from 685 to 715. These changes increased the gas oil yield from about 55 to 60%. The additional gas oil came from a 1% to 2% loss on the gasoline and a similar loss on the coke yield. The gas and butane yield also dropped off.

It was definitely a benefit to the refinery to reduce the pressure. One other benefit was obtained from these changes—a much softer coke was produced. Before they had been running a good 8 hours or longer on the decoking and now it's down where they are finishing up in 8 hours easily. This softer coke cuts out a lot faster and is not nearly as damaging to equipment.

Wheeler: Thanks, Jack. Does anybody on the panel have any comments he would like to make on these or other questions on delayed coking? What about some comments or questions from the floor?

? From Floor: Has anybody had experience with Dow Corning anti-foam agents in vacuum flashing, visbreaking, or delayed coking?

Buchanan

Buchanan: We've had some experience with silicone anti-foam compounds in asphalt on vacuum distillation. We used them mainly to prove whether or not we had foam. That is, we know that it will break a foam, and we can see that it does by an immediate increase in the level at the bottom of the tower We have foam standing in the tower. Unfortunately, we can't use it because we have to make penetration asphalt from the bottom of the tower, and the silicone retards the boiling when we run a residue distillation to check the penetration on the base asphalt. It retards the boiling and some way or other holds up light material in the asphalt, and we can't make residue penetration for state specifications. It softens up the material, in other words.

It also has the property of giving a clean penetration. That is, when you punch the needle in the asphalt it comes out clean. Asphalt doesn't cling, and that sometimes throws you off, even on a penetration grade asphalt. But, it is quite commonly used in asphalt plants to stop foaming, caused by a wet truck or a wet tank car during loading of 350° asphalt. It's fantastic what a small amount will do. A quantity of 50 cc will kill the foam in a 5000-gal tank.

Question: Do you have propane de-asphalting?

Buchanan: No, we haven't.

? Wheeler: What is the highest temperature at which you've used that anti-foam agent?

Buchanan: They make various grades, or boiling ranges, and we've used it in the transfer inlet to the tower at 825°F. They also make silicones that decompose at various temperatures and pressures. Our pressure is 50 mm Hg absolute on the vacuum tower. We are about to try two now that will decompose at about 500°F and 700°F. The idea is to use them for foaming where they

would flash or decompose and not ruin our bottom product, penetration grade asphalt.

? Wheeler: Do you have any information that tells when anti-foaming agents do decompose and do they still give you the anti-foaming action at decomposition temperatures?

Buchanan: We are going to try it. Actually, we don't expect that it will.

Wheeler: Mr. Chenault has pointed out that the Lummus Co., in a coking pilot plant, has used silicone and non-silicone type anti-foaming agents, and they have proved effective in reducing the foam. Of course, the next question that would come up is, are these agents economical?

Buchanan: Our installation features two radioactive coke level indicators on each drum. We have one located at 43-ft outage level and one located at 25-ft outage level. Thus, we have both a source and a receiver at each of those outage levels on each drum. By using this type of an installation, we can see both the froth and the coke as they pass the gauge.

We get a check on our froth height early in the day and if we feel it is too high we raise our transfer line temperature. That generally brings the froth height down to something that we like to see, maybe less than 10 ft. We found that the 43-ft outage level indicator is not sufficiently accurate to predict a coke drum outage for the next day. The one at the 25-ft outage level will predict 80%, within about 12 inches, the remainder, 12+ inches. Some of those may be as much as 24 or, sometimes, 30 inches off.

We have had our permanent installation in use since the latter part of May, and since that time we have brought our average coke drum outage from about 25 ft down to about 18 ft average for a month. To average this we may run as low as 14 ft and sometimes as high as 20.

In my opinion, the way to utilize coke drum space most efficiently is to vary the drum cycle. Perhaps shoot for a 15-ft outage on a 24-hour cycle, but if you don't make that outage, run over cycle time by a half hour or cut by a half hour, or maybe even an hour early. And then increase or decrease your feed to compensate for the altered cycle time.

? Wheeler: What I was wondering about is this: you have apparently had good luck in reducing foam height by raising transfer line temperatures; what is the effect in reducing foam of a 2° or 5° raise in transfer temperatures?

Buchanan: We don't have good quantitative data yet on that. Let me explain our situation this way—we like to fire by our vapor outlet temperature on our coke drum. If we run at a 920° tranfser temperature, our vapor outlet temperature then gradually rises during the day. It may be around 825 in the morning and will rise to 840+, at switch time. We like it between 845 and 850 if possible. We feel that at 840 to 845 we have 5 or 6 ft of froth on top of that coke bed. For 825 on the vapor outlet, it may run from 10 to 15 ft, depending upon our stocks, and a few other things.

Wheeler: Are there any more comments on coking?

? McCandless (Pan-Am Southern Corp.): What limitations are there on the Conradson carbon content of the coking furnace charge on a delayed coking unit? Does anybody have a practical upper limit as far as that is concerned? How high do you go? As high as 15%?

Comment: As high as 30%.

Wheeler: 30% Conradson Carbon! That's very interesting. Who runs a delayed coking at that level of Conradson Carbon?

Ferguson: NCRA does in Kansas. Whether or not they actually ran any that high or not, I don't really know.

Wheeler: Was that what it was designed for?

Maddocks: That's just about right. Actually McMurrey has an 8000 b/sd decarbonizer and, in that particular unit, the charge stock has about 4% Con carbon. We're circulating about 1600 b/sd through the coking heater or say 20%, so five times 4 would be about 20% Con carbon.

Wheeler: Is that the one you were talking about where they used lots of steam in the heater?

Maddocks: Yes, that's the problem. As we see coking units, the heater is the critical item. As we know, the two important factors influencing coke deposition in tubes are radiant rate and fluid velocity. Our method of handling that problem is to get lots of steam in the tubes and keep the velocity of flow to a maximum.

Here are a couple of other points I'd like to mention covering the Con carbon of the gas oil product. I believe we all agree that Con carbon on the gas oil is quite dependent upon the fractionation obtained between zone and the draw-off, or the scrubbing effect. It's carry-over from the flash zone that affects the Con carbon in the draw-off steam. For instance, we had some trouble down there and coked wash trays to the point where we weren't doing any scrubbing at all. The Con carbon went up to a maximum of about 0.6%. On the design basis for the unit's original installation, we come up with a Con carbon of about 0.3%. Actually, by more proficient scrubbing of vapors which involved redesign of the wash trays and changing some spray nozzles in that section, the Con carbon has been reduced to about 0.15%. That's a pretty good quality gas oil.

In general terms, the effect of pressure on a delayed coking operation is as follows: at high pressure, you would expect to make about 1.5 times the Con carbon in the feed stock as coke. With lower pressure operation at McMurrey, we make about 1.3 times the Con carbon so there's about a 20% decrease in the amount of coke produced. By producing less coke—less coker gasoline and less gas is made because less cracking has occurred. Reducing the pressure decreases the amount of cracking.

If you consider fluid coking, you obtain about 1.1 or 1.0 times the Con carbon in the feed stock as product coke. Actually, the reason for less coke is that some of the coke is burned in the process. The volatility of coke

Where this Information Came From

THE all-day question-and-answer session is a popular part of the WPRA's annual regional meeting.

The 10-man panel replies to prepared questions, then answers questions from the floor.

The group of five refinery men and five engineering men was directed by Harry K. Wheeler, Pan-Am Southern Corp., El Dorado, Ark.

The refiners were: N. S. Banta, Pure Oil Co., Nederland, Tex.; E. A. Heike, Premier Oil Refining Co., Ft. Worth, Tex.; L. K. Buchanan, Bell Oil & Gas Co., Ardmore, Okla.; M. S. Moody, Lion Oil Co., El Dorado; and O. A. Fuchs, Pan-Am Southern Corp., El Dorado.

The engineering panel: R. R. Maddocks Blaw-Knox Engrg. Co. Pittsburgh, Pa.; J. S. Clarke, Esso Research & Engrg. Co., Linden, N. J.; D. F. Ferguson, The Refinery Engrg. Co., Tulsa, Okla.; J. F. Walter, Universal Oil Products Co., Des Plaines, Ill.; and D. E. Womeldorph, Houdry Process Corp., Philadelphia, Pa.

produced is more dependent on the temperature held in the coke drum, than on the pressure of the operation. Therefore, temperature is the important variable concerning coke volatility.

? Ferguson: What order of Con carbon does Pan-Am discover on its gas oil?

Fuchs: As high as 0.15. It has been below that in the past. We started out at 0.03. I think our charge rate is higher now, and the Con carbon is around 0.15.

? Ferguson: How about gravity on your gas oil? This was about a 30 gravity coker gas oil.

Fuchs: About 28 gravity.

Ferguson: That's pretty high gravity, and I still think that 0.15 is the upper limit on a gas oil that light.

Wheeler

Wheeler: Regarding the factors that Bob Maddocks was pointing out: whether they are the effect of pressure or the effect of reducing recycles—I don't know, but undoubtedly when you lower the recycle you are going to get a little lower carbon yield on your feed because you are not cracking the recycle gas oil. On fluid coking there is no recycle. In other words, they take out such a heavy gas oil there is nothing left to recycle. I think recycle might be the reason the coke yields are so low at low pressures.

Jandacek: (D-X Sunray): On our test operation that was mentioned before, by Mr. Eppard, we (Sunray at Duncan) actually did raise our chimney temperature during that operation; when we raised the chimney temperature we got a heavier gas oil. It reached about 0.2 Con carbon.

? Alexander (Pan-Am Southern Corp.): When you lower the pressure on delayed coking unit coke drums, do you increase coke fines carry-over to the fractionator?

Comment: On the Ucan test, the coke drums had been on stream for a long time, something like a 100 days, and it would be very difficult to tell whether this coking in the transfer line was the result of just being on for a long time, or caused by the changes in the operation. As Mr. Eppard points out, when they went into the Ucan test, they had 14-in. gate valves and they had considerable difficulty in opening and closing them when they went to this lower pressure. They have now converted to wedge plugs which they hope will solve their opening and closing problem.

Stark (Ohio Oil Co.): A similar type of trouble was experienced on the delayed coking unit at the Ohio Oil Co., Robinson, Ill. The trouble was eliminated by washing the valves with coke drum overhead vapors each time a drum switch was made. The Ohio Oil coker has an angle (upstream) valve and a gate (downstream) valve on each line.

One hour before switch time the operators pinch the gate valve enough to increase the coke drum top pressure from 1 to 1.5 psi and the valve is kept in this pinched condition for approximately 30 minutes. Next, the operators pinch the angle valve to increase the coke drum pressure from 1 to 1.5 psi above the previous pressure so that it is known that the angle valve is maintaining the coke drum pressure. The gate valve is again opened and the angle valve is kept pinched for approximately 30 minutes until the coke drum switch is carried out. The valves are pinched closed about one third of the way.

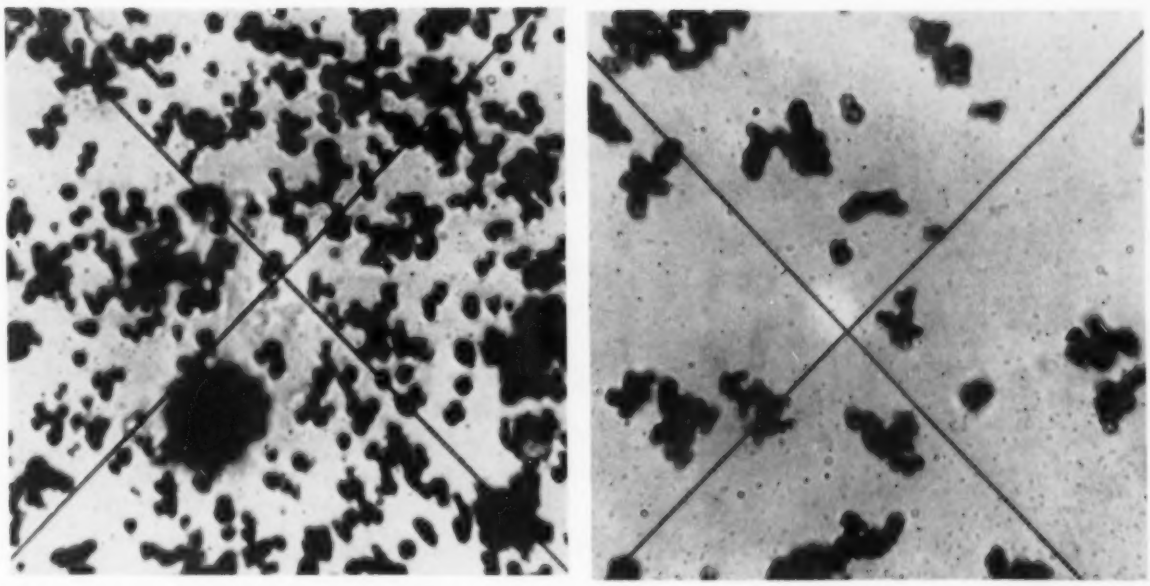
By pinching the valves to gain a slight pressure increase, the vapor velocity through the valves is increased enough to clear coke out of the seat and bonnet free spaces. Before this was done the Robinson refinery used to require three and four men to manipulate the valves, and the force bent valve wheel gears crooked.

After three or four cycles of pinching or washing the valves, the valve action is free enough so that during the switch the pressure is maintained on the coke drum by one man operating the angle valve with one hand. The bonnets of the vapor line angle valves are flushed with unit gas oil but the gate valves employ no type of flushing mechanism.

? Question: Have you been doing this long enough to know whether the valves erodes because of this increased velocity through them?

Stark: We have been doing this for 2½ years and we have been shutting down every six months—we haven't noticed any erosion.

Editor's Note: In several of the previous sections of this series, Mr. R. R. Maddocks' name was spelled incorrectly. Mr. Maddocks is with Blaw-Knox Engineering Co.



SIMILARITY OF FIELD TO LAB-MADE SLUDGE led Esso to new test technique. At left is sludge formed during season storage of heating oil showing discrete particles roughly 2 microns in diameter; at right is sludge formed by storing the oil 16 hours at 212°F

New Fast Test Method for . . .

Distillate Storage Stability

By W. A. KONRAD and T. S. TUTWILER, Esso Research and Engineering Co., and N. L. SHIPLEY, Imperial Oil Ltd.

FILTER PLUGGING is the basis of Esso Research and Engineering's new, fast, easy-to-run test for the storage stability of heating oils. Why filter plugging? The test had to simulate field conditions as nearly as possible, and it had to be suitable for both research and production control.

Why another stability test for middle distillates now? 1—Existing tests were not entirely satisfactory, and 2—the need for a reliable check is urgent and growing more urgent. The use of cracked middle distillates (from catalytic cracking for higher gasoline octanes) to fill the growing middle distillate fuel demand is increasing. This demand increased 91% since World War II—from 182-million bbl to 350-million bbl between 1947 and 1953.

Esso's "Accelerated Filter Plugging Test" is designed to assure the refiner that his fuel will not sludge in field use. Unless careful processing, or additives, or both, are used, sludge can form in middle distillate fuels incorporating cracked stocks. These fuels are often stored for long periods, encouraging sediment formation that would downgrade performance. (See photomicrograph above left.)

The "AFP" test, which works for both additive-containing and non-additive-containing fuels, was developed after considerable work by Esso Research and Engineering Co.

Table 1—Types of Oils Evaluated by Accelerated Filter Plugging Test

Crude sources	Canada (Alberta) Louisiana East Texas Venezuela
Type of treating	Untreated Treated (caustic, acid, etc.)
Number of base blends	6
Types of blends	Various proportions of straightrun and catalytically cracked stocks. Two of the blends also contained thermally cracked components.
Number of additives	4
Total number of test oils	11 (6 additive oils, 5 nonadditive oils).

Table 2—Description of Field Stability Tests

Location	Eastern U. S.		Canada	
Test No.	A	B	C	
	1st yr.	2nd yr.		
Total No. of units	60	50	168	40
No. units per test oil	15	10	84	20
No. of test oils	4	5	2	
Range of oil consumption, U. S. gal/yr	770-5500	700-2200	500-2400	
Storage tank capacities, gal	275-2000	275-1500	275-550	
Type of filter	Cotton yarn wound		Felt	
Average age of installation, yrs	11	9	2.5	
Firing rate, avg. gal/hr	1.6	1.5	1.2	

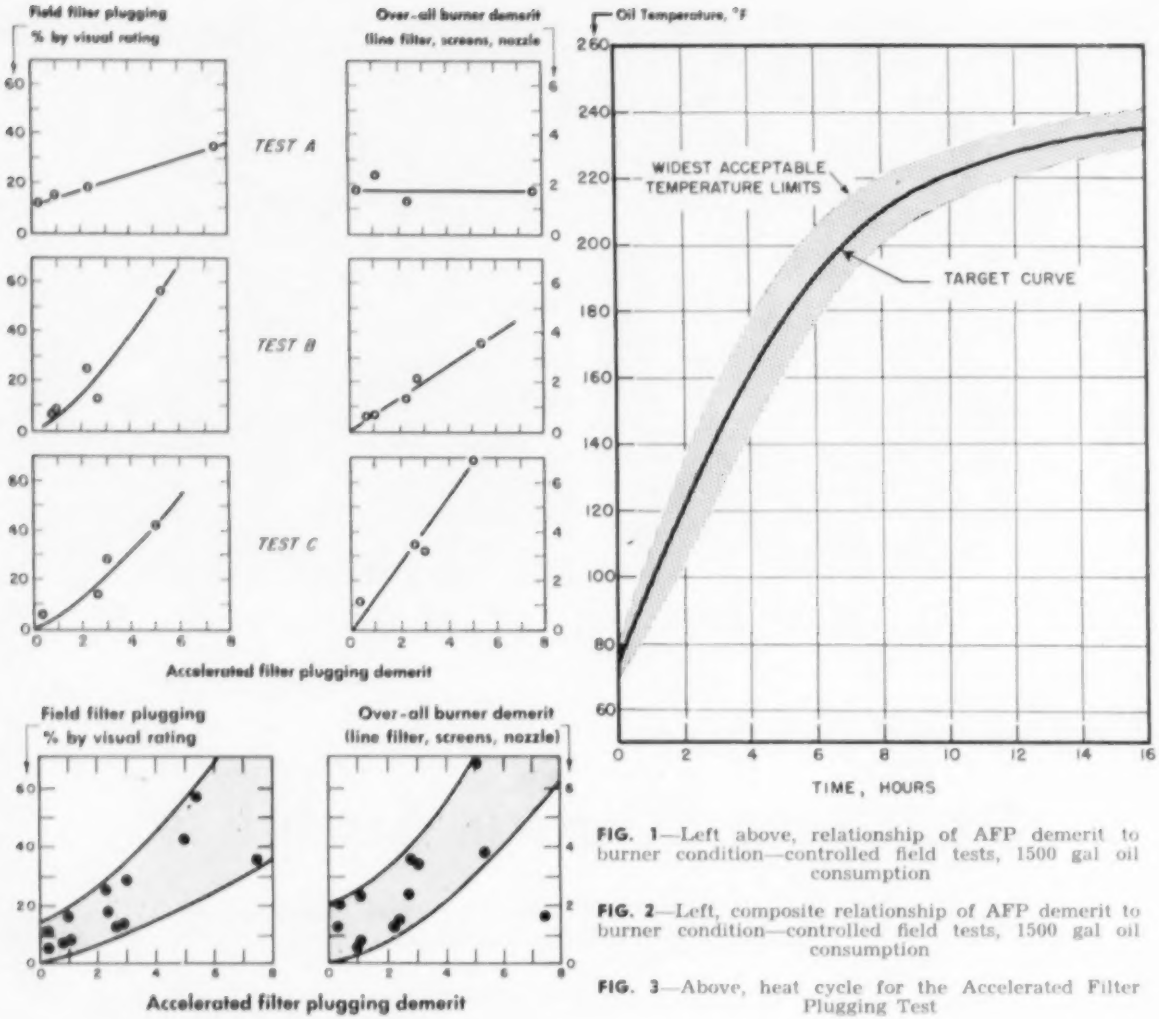


FIG. 1—Left above, relationship of AFP demerit to burner condition—controlled field tests, 1500 gal oil consumption

FIG. 2—Left, composite relationship of AFP demerit to burner condition—controlled field tests, 1500 gal oil consumption

FIG. 3—Above, heat cycle for the Accelerated Filter Plugging Test

Developing the Test

In setting up the Accelerated Filter Plugging (AFP) Test, the approach was to approximate as nearly as possible what happens in the field.

It was found that short term storage at controlled high temperatures produced the same type of sludge particles found after a season's storage in the field at ambient temperatures. (See photo, p. 145, at right.)

The sludge from the AFP Test was tested by measuring in the same way as a burner would measure it—sludge accumulation on a cotton or felt line filter. This part of the burner collects the most sludge and is a good indicator of the condition of the rest.

Therefore, the test method selected to study the sludge consisted of filtering out the sludge with a simulated line filter; measuring pressure drop across the filter; weighing sludge held on the filter; and visually rating the AFP filter element (because visual ratings of field filters are generally indicative of over-all burner conditions).

Testing the Test

Three field tests, covering 11 different oils (6 were additive containing, representing 4 different additives) showed good correlation between the AFP Test and field stability for a wide variety of heating oils. A description of the oils used is given in Table 1.

Two tests were made in the U. S., each for one heating season; and the third test was in Canada for two consecutive seasons. All were in typical home heating installations using gun-type burners, which represent about 85% of the burner population in the U. S. and Canada. Test installations included small and large, as well as new and old heating units. Table 2 describes the field tests.

All test units were rated by two different systems. The first system used a line filter (cotton yarn wound, or felt) as the basis of evaluation, and the per cent of the filter plugged was rated visually.

The second rating system involved the entire unit with various parts rated on a 0-10 demerit scale. The resulting demerits were multiplied by the weighting factors shown on next page, then

Table 3—Demerit Rating Scales (Pressure Drop and Sediment Weight) for Accelerated Filter Plugging Test

Pressure or Weight Demerit	Final Pressure Drop cm Hg	Total Sediment Weight mg
0	0-2	0-5
1	2.1-5	5.1-10
2	5.1-10	10.1-20
3	10.1-15	20.1-30
4	15.1-20	30.1-50
5	20.1-25	50.1-80
6	25.1-30	80.1-120
7	30.1-35	120.1-170
8	35.1-40	170.1-230
9	40.1-50	230.1-300
10	50.1-plugged	300.1-up

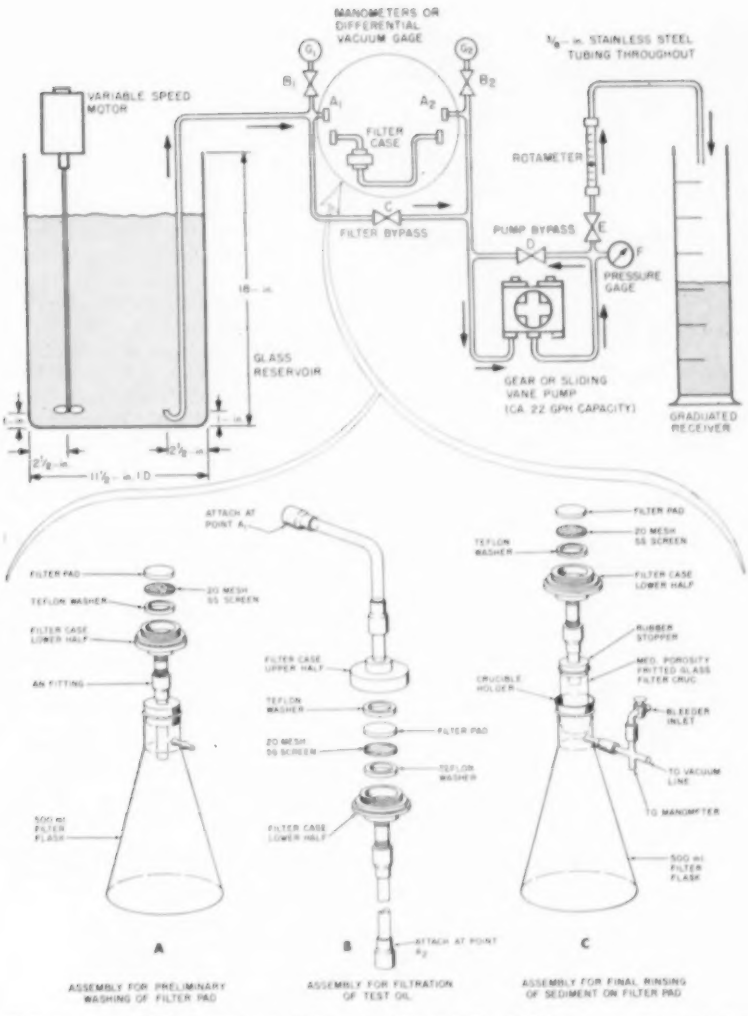


FIG. 4—The AFP apparatus (above) with details of filter case shown below

added to give the over-all unit demerit on a 0-10 scale.

Burner Part	Weighing Factor
Line filter	0.25
Pump strainer	0.25
Nozzle strainer	0.20
Other nozzle parts	0.30

AFP demerits on the test oils before the start of the field tests were then compared with the field test results. Excellent correlation with field filter plugging was obtained in all three tests, and the correlation with over-all burner condition was excellent in Tests B and C. Fig. 1 shows the correlations for each test.

Fig. 2 represents areas of correlation when the results of the three individual tests are made into a composite plot. While the composite plot does not define the correlations as sharply as the individual plots which represent less variation in oil type, it is good, considering the fuel types, treating conditions and additives covered.

Diesel fuel field filter plugging tendencies, though not evaluated in the preceding tests, have been found predictable by the authors when using the AFP Test.

How to Run the AFP Test

The AFP Test consists of heating a sample of the test oil at a controlled rate (see Fig. 3) for 16 hours to accelerate sediment formation. The sample is then cooled and filtered at a constant rate by a gear, or sliding vane pump, and piping arrangement as shown in Fig. 4.

After 12 liters have been filtered, the final pressure drop across the filter pad and the weight of sludge on the pad are recorded so that demerits can be calculated from Table 3. On this scale, 0 is excellent and 10 is poor.

Visual demerits are obtained by comparison with the standard pads shown in Fig. 5.

Demerits from Table 3 and Fig. 5 are averaged arithmetically to obtain over-all AFP demerit for the test oil.

Test reproducibility is good, with a standard deviation of 0.7 at the 4-demerit level (see Table 5).

A single pump and filter setup can filter two test samples in an 8-hour day (including filter pad preparation and rating). About 20 hours is needed for the accelerated aging cycle (usually run overnight) and cooling prior to filtration.

The detailed test procedure is as follows:

1—Sample Preparation: Preformed sediment may be present in suspended form in the sample of test oil as received. Depending upon the information desired, preformed sediment may be: (a) first removed by filtration of the oil through sintered glass or paper, (b) evaluated by conducting a filter plugging test before accelerated aging of the oil, or (c) left in the oil to show the filter plugging effect caused by preformed sediment plus sediment formed during the thermal treatment.

For refinery control purposes, alternative (c) is followed. When an AFP rating is desired on field samples that have been exposed to contamination in transit and handling, suspended sediment should be removed as suggested under (a) above.

2—Accelerated Aging: a 4½-gal portion of test oil at room temperature (70-80°F) is transferred to a 5-gal, rectangular, tin-plated steel can that has been cleaned previously with petroleum ether and acetone, then dried.

The can containing the test oil is then placed in a heated chest to undergo the accelerated aging cycle, which takes exactly 16 hours.

During the heating cycle, the oil temperature is measured and recorded automatically, using a thermocouple placed in the center of the oil sample. A special vented cap supports the thermocouple in the sample can.

The time-temperature relationship to be followed by the test sample during the 16-hour heating cycle is given in Fig. 3. The heavy line on the graph shows the target temperature at any given time; the shaded area indicates the widest acceptable limits.

Conforming to the heating cycle specification is of the utmost importance for good reproducibility. At the same time it is important to avoid local overheating. The heating box

■ Distillate Stability Test

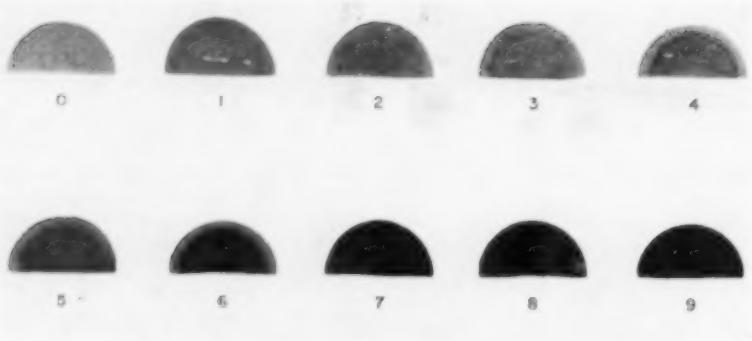


FIG. 5—Visual aid rating scale for the AFP Test

and the rate of heat input, therefore, have to be carefully designed.

For convenience the authors have used a fully insulated heating chest having a grid of steam coils in the bottom. The grid is composed of 10 lengths of ½-in. OD copper tubing, 20 in. long; connected by two 25-in. long, ⅜-in. OD headers.

Test sample cans are placed directly on the grid and the steam pressure is maintained at 80-90 psig (325-330°F). This arrangement gives the desired heat cycle and eliminates the possibility of local overheating.

Inside chest dimensions are 25 in. x 25 in. x 20 in. high, and it holds 4 test samples. If less than 4 samples are to be run at any given time, the remaining positions in the box are filled with cans containing 4½ gal of "dummy" oil. To provide uniform heat radiation, the 4 cans are placed symmetrically in the chest, each can being equidistant from the chest walls and the adjacent cans. Cans with test samples have thermocouples, while cans with "dummy" oil are simply capped loosely to permit breathing.

The possibility of a combustible mixture occurring under the test conditions must be recognized, and adequate safeguards should be taken to exclude sources of ignition.

After the heating cycle, the oil is cooled to 72°F±5°F for 3½ to 4 hours in a bath of tap water.

3—Operation of Filter Plugging Apparatus: After the heat-treated oil is cooled to 72°F, it is shaken thoroughly in the can to insure complete suspension of sediment. Half of the sample then is transferred to the glass reservoir. The remainder is reshaken and then added to the reservoir.

The inside of the can is visually inspected to detect any adhering deposits. The presence of these deposits indicates that the test oil is probably quite unstable, but at the same time invalidates the rest of the test. However, the authors' experience indicates that adherent deposits occur rarely.

From this point, until the completion of the test, the oil is stirred continuously at as rapid a rate as possible without causing vortexing.

With plugs affixed at positions *A1* and *A2* (see Fig 4) closing the filter case connections, and with valves *B1* and *B2* closed and *C*, *D* and *E* opened, the pump is started. By gradual adjustment of valves *D* and *E*, the ratio of discharge oil to recirculation oil at the pump is controlled to give 10 psig reading at point *F*, and a discharge flow of 1 gal/hr. (The rotameter is calibrated prior to the test with an oil having a Saybolt Universal viscosity at 100°F of 33.0 and API gravity of 33.0°.)

Lines are flushed with 500 ml of the test oil, which is collected and discarded. After flushing, the pump is stopped, and the plugs at the filter case connection (*A1* and *A2*) are removed in preparation for attachment of the filter assembly. The adjustment of valves *D* and *E* is not changed, pending start of the actual test run.

Meanwhile, the 1¼-in. woven felt filter pad is prepared by rinsing several times, under suction, with n-heptane to remove any heptane-soluble matter contained in the wool felt. For this operation, the pad is supported in the lower half of the filter case.

The pad is dried at 210°F for 30 minutes in an explosion-proof oven, removed and weighed immediately (within one minute) while it is warm. The hygroscopic nature of the pad makes it undesirable to cool it before weighing.

The pad is then transferred to the filter case, which is assembled as shown in the detail. The case must be sufficiently tightened to prevent oil leaks around the Teflon washers or the pad. The assembly is attached to the apparatus at the unions previously closed by plugs *A1* and *A2*.

With the filter case in position and valves *B1* and *B2* and *C* closed, and valves *D* and *E* at their previous adjustment, pumping is resumed, and the test run proper is begun.

Throughout the remainder of the test, pressure at point *F* is held at exactly 10 psig, and the rotameter is set at a position corresponding to a 1 gph flow with the calibrating oil.

If wide variations in oil gravity and viscosity are anticipated, the test should be run at a throughput of exactly 1 gph. For production control work, however, small variations (1 or 2 units) in gravity and viscosity can be disregarded, and the unit run to a predetermined rotameter setting with satisfactory results.

Pump discharge pressure and flow rate are controlled by suitable adjustments of valves *D* and *E*.

Although air bubbles are commonly observed in the first 1-2 liters throughout, continuous or excessive air in the oil indicates line or filter case leaks that should be remedied. The valves *B1* and *B2* are opened carefully, and the pressure drop across the pad is measured. Manometers, vacuum gages or a differential vacuum gage can be used for this measurement.

A record is kept of running time, volume throughput and pressure readings at convenient intervals every 1-2 liters. Unstable test oils will show rapid pressure increases and will consequently require closer observation than stable oils.

The run is continued until 12 liters of oil have passed, after which the final pressure drop is recorded, valves *B1* and *B2* are closed to prevent test oil from draining back into the vacuum gages or manometers, and pumping and stirring are stopped.

With unstable test oils that form large amounts of sludge, plugging of the apparatus may occur before passage of the required 12 liters throughput. Conditions that indicate the onset of severe plugging are : (a) pressure drop in the range of 50-70 cm Hg, and (b) excessive vapor bubbles

Table 4—AFP Test Reproducibility

Laboratory	Demerit Oil A	Rating Oil B
A	4.7	9.3
B	3.7	8.7
C	3.2	6.7
D	3.0	12.0
E	3.3	6.3
F	3.0	8.3
G	—	11.3
Average	3.5	8.9
Standard deviation	0.7	2.1

in the oil at the discharge line from the pump, as observed in the rotameter.

However, even if these conditions develop, the run is continued until 12 liters are filtered or complete plugging is reached.

The unit is considered completely plugged only when the pump is unable to maintain 10 psig pressure at the predetermined rotameter setting, or at a flow rate of 1 gph. If this happens, a record is made of the final volume passed, and the final maximum pressure drop across the pad, these being the last readings obtainable under the standard flow conditions. The valves *B1* and *B2* are then closed and pumping and stirring stopped.

4—Measurement of Collected Sediment: The filter case is carefully dismantled, leaving the pad in position in lower part of case. (See detail.)

A vacuum of 8 cm ± 2 cm Hg is applied at the filter flask. This is obtained conveniently by adjustment of the air bleeder inlet. The pad and the sediment collected on it are washed carefully with 50 ml n-heptane, added in small successive portions to remove traces of test oil.

Care is taken not to disturb the sediment on the filter pad, because the sediment-covered pad is subsequently rated visually.

Washings are passed directly through a tared fritted glass crucible to catch any sediment that might have been dislodged. The crucible is then washed separately with an additional 50 ml of n-heptane.

Pad and crucible are dried at 210°F for 30 minutes. The crucible is cooled in a desiccator and weighed. The pad is weighed immediately after removal from the oven. The total weight of sediment on the pad and crucible is recorded. The appearance of the pad is rated accordingly to the visual rating scale, Fig. 5.

5—Shutdown of Apparatus: Between test runs in the filter plugging apparatus, the lines should be purged of test oil and sediment from the previous run. For prolonged idle time, complete drainage of the apparatus is recommended.

Rating of the Test Oil

The performance of the test oil is rated by the following three criteria:

1—Pressure demerit caused by final pressure drop across the pad.

2—Weight demerit caused by total sediment retained by pad and crucible.

3—Visual demerit caused by appearance of sediment deposit on pad.

These three demerits are numerically averaged to obtain the AFD demerit rating for the oil. The demerit scales for the pressure and weight data are shown in Table 3, and the visual demerit rating scale in Fig. 5.

As previously mentioned, with unstable test oils, plugging of the apparatus may occur before passage of the required 12 liters throughput. In these situations, the over-all demerit at plugging is then corrected by use of the following relation:

$$\text{Corrected AFP Demerit} = A\left(\frac{12 \text{ liters}}{B}\right)$$

Where:

A—Over-all demerit at plugging

B—Total throughout at plugging, liters

Corrected AFP demerits for test oils that cause complete plugging usually exceed 10.

Test Reproducibility

Test reproducibility is sufficiently good to make the AFP valuable in refinery control testing as well as in fuel and additive development research. The reproducibility of the test is indicated in Table 4 which compares the AFP demerits obtained on 2 reference oils in 7 cooperating refinery laboratories.

Table 4 suggests that test reproducibility decreases as average AFP demerit (instability) increases. While this has been found in practice to be so, reproducibility on oils in the 0-4 demerit range is considered quite good for a performance type test. This is the range that is of most practical interest.

Oils having demerits above 4-5 are sufficiently unstable so that better reproducibility than that possible with the AFP becomes unimportant.

Filter Case Details

The filter case is Air Filter No. E-9, Eclipse Air Brush Co., 391 Park Ave., Newark, N. J. Case is equipped with 20-mesh steel screen and two ⅛-in. Telflon gaskets with 1¼-in. OD and exactly 1-in. ID.

The filter element is woven wool felt cloth No. 281, T. Shriver and Co., Harrison, N. J. Individual filter pads are cut to 1¼-in. diameters.

This article is a condensed version of a paper presented by the authors before the Petroleum Div. of the American Chemical Society at the Sept. 1955 meeting.

Meet the Authors

Mr. Shipley

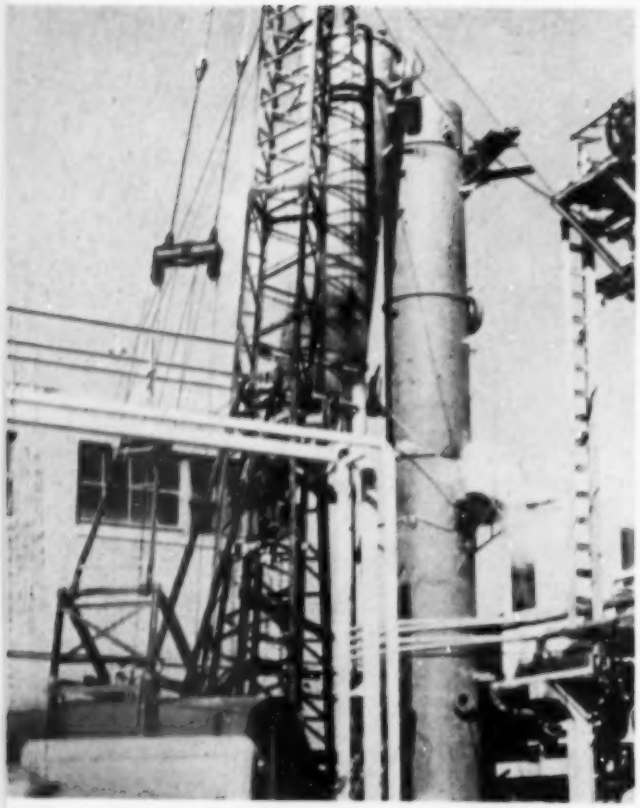
Dr. Tutwiler

Mr. Konrad

W. A. Konrad is in New York City as assistant head of the Sales Development Section in the Export Sales Department of Creole Petroleum Corp. He moved to Creole this spring from the Esso Research and Engineering Co. where he was group head in charge of diesel fuel work in the Products Research Div. Mr. Konrad holds a B.S. degree in chemistry from Moravian College and a B.S. in Chemical Engineering from Lehigh University. He joined Esso in 1947 after 3 years with the Bethlehem Steel Co. in Bethlehem, Pa.

Norman L. Shipley, senior chemist in the manufacturing service section of Imperial Oil's research department at Sarnia, Ontario, was born in Amherst, Nova Scotia. He received a B.S. degree in chemistry (1943) from Mount Allison University, Sackville, New Brunswick, joining Imperial that year as control chemist at the Halifax refinery. He transferred to the Sarnia research department in 1952, receiving his present position in May, 1955.

T. S. Tutwiler is a chemist with the Esso Research and Engineering Co. in Linden, N. J., where he heads the Additives Research Section of the Products Research Div. He joined the research firm in 1943 after getting a Ph.D. degree in organic chemistry from the University of North Carolina. Earlier, he earned a B.S. degree in chemistry from the University of Richmond.



BIRTH OF A COLUMN—in three stages. One of many tough, tight-fit jobs at Texas City Refining, where they ask the question below.

THIRD SECTION of de-ethanizer column going up

Why Lose Time For a Revamp?

How Texas City doubled alkylation capacity, making all tie-ins during a normal shutdown

By C. F. TENNISON, Maintenance Supt., Texas City Refining, Inc.

TEXAS CITY REFINING, INC., has just completed a major revamp of its HF alkylation unit without lost onstream time. Equipment and line were placed so that all tie-ins could be scheduled during a regular shutdown. Therefore, no downtime on the existing unit could be charged to construction. The unit's capacity was about doubled.

New construction is filled with compounded complexities, especially for an expansion of an existing unit. So when Texas City Refining's top management decided to expand existing facilities, and said, "Do it with a minimum of downtime," we went one better—we did it with no chargable downtime.

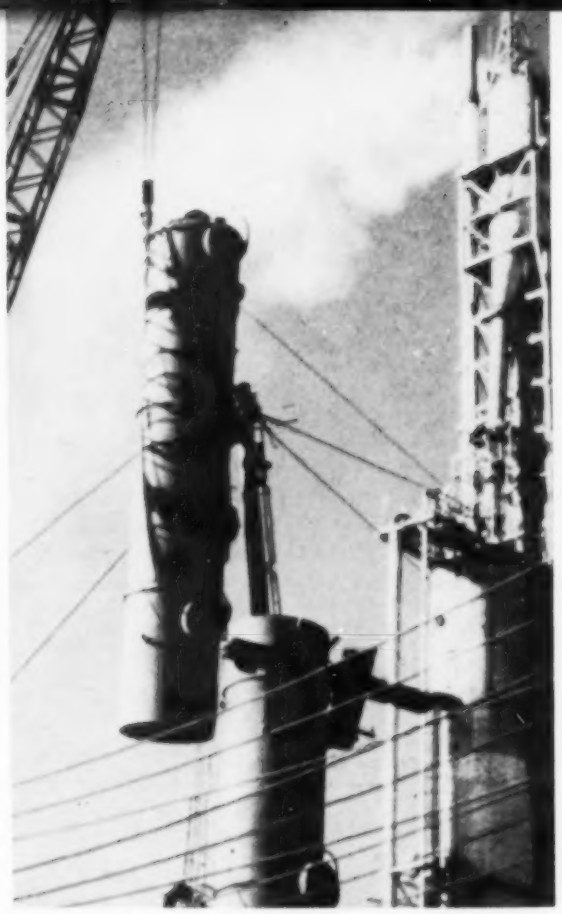
For such an expansion, plant forces must plan and coordinate all work.

Engineering locates equipment in whatever space is available in the area. Construction hazards enter into this planning, because they sometimes outweigh actual square feet of ground.

Piping and accessories are routed to and from the new equipment in a smooth flow that does not bottleneck construction.

Construction progresses as far as possible before shutdown. Hot taps can be made, or lines and equipment can be isolated. Also, stub ends can be made and valved off, so that a minimum of tie-ins will be needed when time is such an important factor.

Coordination and cooperation of all plant forces are absolutely essential. This includes both maintenance and operations, and outside contractors.



GIN POLE holds weight as crane guides last section.

General Planning

At the start, a close study of all work needed for the revamp of the HF alkylation unit was made. Each pump, tower, exchanger, reboiler, condenser, line and vessel was given a number.

Contractors erected all towers, placing them on foundations laid by themselves, or by Texas City Refining's maintenance forces. It was thought, and proved, that time would be saved by having the maintenance department forces put down the foundations. In actual construction, the maintenance department completed some foundation excavations before the drawings were finished. This was possible, because the entire project was engineered in our own engineering department, and close coordination of interested departments was in effect at all times.

Completion up to tie-in was made by the contractor, after foundations were down and towers erected. There was excellent coordination between contractor and refinery forces, because the contractor's superintendent worked out of the refinery maintenance office.

Piping and fittings were moved to the job site as the pipe work started. By doing this, time was saved on the actual installation of line control valves and fittings because all material needed for the entire line was on site.

A safety department representative was present on the job site at all times. With this man present, and with preplanning of safety needs, there were no interruptions of work because of unsafe conditions or actions during the entire project.

Employe safety was also guarded many times, during piping erection, by inclosing scaffolds completely with "tarps" and asbestos blankets. This protected workers from the danger of acid spills and fires (there were neither during this project).

Electrical work was done largely by the maintenance department, because the work had to be done on the existing unit while it was onstream. Work not done by maintenance was supervised directly by the maintenance electrical foreman, or his electricians.

Instruments were installed by the contractor, under direct supervision of the maintenance instrument department. The supervision of contractor forces by refinery maintenance foremen worked amazingly well, both in electrical and instrumentation work. There was no friction between the forces, as each understood its responsibilities, and worked in a very agreeable manner.

Work schedules for the HF alkylation unit expansion project were set up in accordance with deliveries of materials. Weekly checks were made on deliveries to expedite items appearing to be slow in reaching the project site.

In very few situations was it necesary to revamp the work schedule because of slow or late equipment deliveries.

From Steam to Oil

A decision was made to revise the exchange medium on the HF alkylation unit reboilers from steam to hot oil, thus giving better control of reboiler temperatures and reducing our excessive steam load.

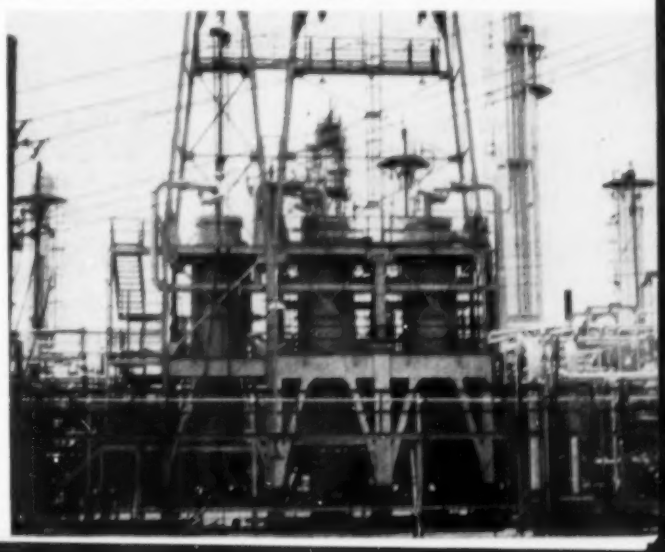
New facilities were needed for the conversion from steam to oil, including hot oil furnace, hot oil drum, hot oil pumps, blow down tank, component piping and instruments.

The relatively large area needed for these facilities normally would present a big problem in a compact refinery such as ours, limited to a minimum of area. However, we were fortunate in having an undeveloped area "tailor-made" for this job.

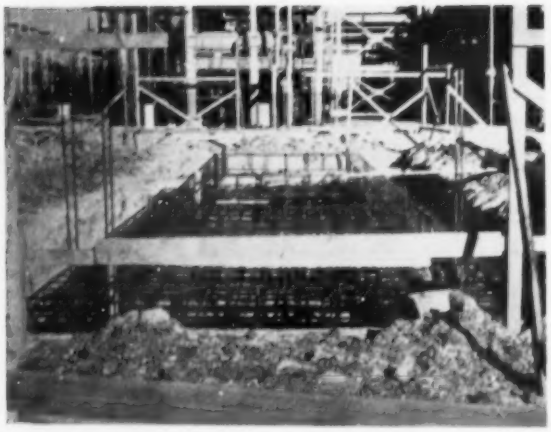
This area, for the hot oil reboiler facilities, was bounded on the east by the HF alkylation unit, and on the northwest by the alkylation blowdown. By having this area, we were able to erect all equipment completely, run all piping, and install all instruments (except the reboiler hot oil control stations) before shutdown.

After the preliminaries of discussion and preparation,

WHICH IS THE NEW CONTACTOR? It was added with a tie-in while the other two (at right) were on stream.



CAT TRACTOR and two cranes handled prefractionator column. Erection posed no problem after site was cleared



FOUNDATION for alkylation unit hot-oil furnace was started early, was almost finished before last drawings.

plant forces began design work, purchased all needed material and equipment, and entered into contracts for the furnace, piping and instrument work. These actions were all started well in advance of the actual construction date, and were closely controlled, to assure good delivery dates and close coordination among all concerned.

Furnace erection was the most time consuming job. We decided to install the hot oil furnace foundation with maintenance department forces to have the site ready at the earliest possible date. (See photo above right.)

Speed in laying the foundation was possible, because we had men available on demand, and had access to blueprints as soon as they were completed.

Other foundations were installed by Southwest Fabricators under a subcontract, and scheduled in order of demand by the overall project plan.

The hot oil furnace was designed, fabricated, and erected by Born Engineering under contract. Their shops made the entire furnace, after the prints were approved. Then they moved to the job site after the foundation was finished—prior to the remainder of the work—giving them the advantage of maximum space for their operations.

Erection of the furnace was started well in advance of the required date for a safety factor. As it happened, there were material difficulties during the erection, and this safety factor was needed. Work on the furnace was completed about one week before the calculated shutdown for tie-in.

Accessory equipment was installed by Southwest Fabricating. Except for the blowdown drum (made by the maintenance forces from a surplus tank), purchasing was handled by plant forces. Because Southwest was also the pipe sub-contractor, the equipment erection was coordinated closely with the pipe work.

Piping and pipe supports were fabricated and erected by Southwest Fabricating under sub-contract. The pipe was prefabricated in their Houston, Texas, shop, and the structural pipe supports were fabricated on the job site.

For both piping and supports, our plant forces handled the design and worked in close coordination with Southwest's superintendent, scheduling priority on the different systems.

Piping erection started at the furnace and progressed to the alkylation unit. It was possible to complete all pipe work in the furnace area and the main headers in the unit before shutdown. Header installation in the unit was possible by extending the existing supports and running this pipe above all existing pipe runs.

Additional control board room for the hot oil controls was available at either of two ends of the control room not used for the alkylation units controls.

We bought an assembled, self-contained board, and installed it while the alkylation unit was onstream. Instrument tubing and electrical work was run in conjunction with the piping and other work prior to shutdown. Work remaining during the shutdown period included tie-ins at each hot oil control station, and calibration of the instruments.

De-Ethanizer Installation

A very good tower foundation for the de-ethanizer column was at the site of the old fixed-bed catalytic cracking unit, which had been torn down to the foundation.

Meet the Author

Mr. Tennison

C. F. Tennison, maintenance superintendent of Texas City Refining, Inc., Texas City, Texas, was born in 1907 at Waco, Tex.

His first job was with the now defunct La Porte Refining Co. From 1928-30 he was still-fireman at Stone Oil Co. (now Pan-American Chemical Co.) He helped build the Republic Oil Refining Co. plant at Texas City and then joined the company as fireman and stillman on various units.

About 1934 he became foreman of the boilermakers, riggers, welders and heavy equipment department, and in 1941 was appointed zone supervisor in charge of maintenance. He went to New Mexico in 1947 to work in maintenance and construction for the state and the Air Corps. In 1953 he joined Texas City Refining in his present position.

The old foundation was used by cutting the concrete inside of the foundation down to the original reinforcing bars, and tying on additional reinforcing bars to reinforce the new concrete poured inside of the reworked foundation.

Though this was an ideal tower location process-wise, there was an erection problem because of the limited space available. Overhead electrical lines, carrying 2300 volts, passed 30 feet south of the tower foundation. The compressor building was 15 feet east of the foundation, and there was a brick building 12 feet west of the foundation. Pipe supports, which could not be moved, were only 16 feet north of the foundation.

A three-stage tower erection was the solution to this problem (see photos pp. 150-151).

A gin pole was erected in two sections by raising the first section, and erecting the second section on top. This pole was sufficiently high to set two bottom sections of the tower, and make a lift on the bottom of the third section.

After erection of the first and second tower sections, a rig with 100 feet of boom was moved in to assist in raising the top section of the tower. The crane boom had to be assembled on the job site after the rig was moved in.

With the crane making lifts from the top of the third section, a large amount of the section's weight was carried on the gin pole. This was done to protect the boom. The crane only served as a guide for the top of the tower while setting the third section.

The main lift drum for this job was about 300 feet from the foundation, and a lead cable was kept in the line of pull by numerous guide blocks.

After the de-ethanizer tower was erected, the foundation was put in for the reboiler, and the reboiler set. Pipe was then erected from the tower and reboiler to points of tie-in on the operating alkylation unit.

Completion of tie-in, while the unit was down for turnaround, took four days. All of the lines had been hydrostatically tested up to the point of tie-in on the alkylation unit.

About Texas City Refining, Inc.

TEXAS CITY REFINING, INC., is the outgrowth of a war-built, Defense Plant Corporation installation. It then had a 10,000 b/d Houdry fixed-bed catalytic cracking unit, a 1750 b/d HF alkylation unit, about 1,000,000 bbls of storage, and attendant facilities.

Ownership of these facilities was acquired in 1948 by three agricultural cooperatives to give an assured competitive source of petroleum products for the very substantial needs of the stockholders. The owner companies are the Cooperative Grange League Federation with headquarters in Ithaca, N. Y.; the Pennsylvania Farm Bureau Cooperative Assn. of Harrisburg, Pa.; and the Southern States Cooperative of Richmond, Va.

Major improvements since 1948 have been made to keep pace with the petroleum industry. Two atmospheric distillation units were installed to provide feedstock for the cracking unit. Another 1,000,000 bbls of storage was erected to give more flexibility, and treating equipment was installed to manufacture more acceptable finished products. The fixed-bed catalytic cracking unit was replaced by a modern 19,000 b/d Houdriflow catalytic cracking unit.

A recent expansion program made changes in the gas concentration plant and HF alkylation unit to include more storage tanks, dryers, contactors, a prefractionator and a de-ethanizing column. These changes improved alkylation feedstock and allowed the use of propylenes along with its previous butylene feed. In addition, a segregation unit was installed for the visbreaker, including a vacuum flash tower on visbreaker feed, a flash tower and gas oil stabilizer on the visbreaker outlet, and an absorber tower for topping unit off-gas.

The adjoining article by Mr. C. F. Tennison, Supervisor of Maintenance at Texas City Refining, Inc., Texas City, Texas, tells how they revamped their HF alkylation unit with no construction downtime.

Prefractionator Installation

The prefractionator tower was located 16 feet north of the Bauxite towers, with the Bauxite tower strainers over what was to be the corner of the prefractionator tower foundation.

Before the prefractionator foundation could be poured, it was necessary to hang and brace these strainers to get them out of the way of the foundation. This was done without interrupting operations, and the prefractionator foundation was put down and ready for the tower when it arrived in the plant.

Two cranes were moved in, and a "cat-tractor" was used in the erection of this tower (see photo). Some cribbing was needed on this job—both cranes had to be "cribbed up."

Work was very slow in this area because of numerous acid lines, and the drift that had to be maintained on the crane booms. However, because of competent labor, it was done without trouble or mishap of any kind.

Contactor Expansion

Two contactors had been made available to us, and they were purchased, dismantled and moved to our refinery when the need for an extra contactor was seen. At this time, the foundation was put down for the third contactor.

While piping the two contactors into service, provision was made to allow tie-in of a third contactor while the other two were onstream.

Not until the alkylation unit was back onstream, after the turnaround, was work started on the third contactor. Steel had been blasted and primed before the start of erection. Concrete fire protection on the east end of the existing structure was removed, allowing structure for the additional contactor to be tied to the existing structure.

After the structure was erected, the shell was placed and plumbed. Piping was started on this shell while tube bundles were being installed in the shell. After completion of the bundle installation, the entire installation was hydrostatically tested.

Fireproofing of the structure was started after the contactor was in service. Insulating this contactor gave additional cooling, and fit in very well with the lay-out of the other equipment.

Please turn page for the . . .

Maintenance and Construction Problem Corner

The MC Problem Corner
Petroleum Processing's Maintenance and Construction Panel answers your questions in this regular monthly feature.

How to Inspect Metal On Live Equipment

What are the methods for determining the condition of metal when equipment is in operation?
Refining, East Coast

The Panel members agree generally that there is no real substitute for a thorough, off-stream, visual and instrument inspection of processing equipment metal condition.

Methods generally used to determine metal condition (usually thickness) in live equipment often miss inside cracks or pits. Also, the reliability of the tests depends directly on the inspector's experience and skill.

However, there are several inspection methods that give satisfactory indications of metal thickness on live equipment, if their limitations are thoroughly understood and appreciated. Most of the "non-destructive" methods of inspecting onstream equipment are most valuable when they indicate when a unit should be shutdown for further and more exhaustive internal inspection.

The ultrasonic wave principle is widely used to inspect metal thicknesses of live equipment. The Audigage, which is based on ultrasonics has a quartz crystal transducer that is placed in intimate contact with the outside surface of the metal to be tested. The crystal is "coupled" to the cleaned and smoothed test spot. Oil or glycerine is used to fill surface cavities.

Crystal vibrations transmit to the metal. The frequency of the vibrations is varied until one or more of the harmonics of the resonant frequencies is found—as noted by a sound level increase in the earphones.

From the resonant frequency thus found, and the known velocity of sound in the metal being tested, metal thickness is found by referring to scales built onto the instrument. Flat or curved crystals are available.

One man can operate the Audigage, which is battery powered and lightweight.

Material behind the surface being measured has little effect on the readings, and laminations are detected. For rough or pitted surfaces, signal strength is reduced, and the resonance band broadened. Thus, a skilled operator can judge the extent of nonuniform metal removed by corrosion.

Pits deeper than about 20% of the plate thickness give no Audigage reading. A disappearing reading warns of serious thinning, and the extent of the area can be found by moving the instrument around this section.

Crystals are now available for elevated temperature use (300°F for continuous use, 450°F for intermittent use), but discomfort and hazard in working on hot surfaces often limits operations to surfaces of temperatures under 300° F.

Though not affected by vessel contents or internal scale, the Audigage has the disadvantage of covering only a small test area. Also, it is difficult to use on curved surfaces and does not test liner condition.

A variation in ultrasonic testers is the Reflectogage, which converts the resonant sound frequencies into light waves visible on a "scope." By proper crystal placement, inclusions, cracks and other discontinuities of almost any size, orientation or location can be detected on inside surfaces.

Though most commonly used to check shafts, pump blocks, welded piping, etc. before fabrication is finished, the Reflectogage can be used in many places on live equipment.

Gamma ray emanation gives another method of testing for metal thickness on equipment in use. The best known instrument of this type is the Penetron, which uses a radium capsule, shielded from a geiger counter-type detector.

Wall thickness is determined by measuring the percentage of radiation (from the radium capsule) that is picked up by the detector, after reflection from the opposite surface of the metal being tested. The thicker the metal, the less the back-scattered radiation picked up by the detector.

Calibration curves can be prepared, based on the material and curvature. Special pneumatic and magnetic holders have been developed to hold the radium-containing head in place.

A special adaptation uses a tangential head, with the radiation source and the detector positioned circumferentially around the tube. In this application, it's necessary for the rays to penetrate both walls tangentially before being picked up by the detector. Curves similar to those for the standard head are also prepared to allow measurement of pipe or return fittings up to 12 in. diameter.

Penetron readings are affected by the contents of the vessel being tested, and by scale or deposits. Even a badly corroded surface can indicate an average reading, and laminations are not detected (of interest where hydrogen blistering is met).

To use the Penetron, one man holds the detection head, and another man operates the indicating instrument. No surface preparation is needed to make a reading, but the instrument does need an outside power source.

The Penetron is useful when more rapid and extensive coverage is needed—giving comparative thickness when the vessel contents are known to be identical at each Penetron test location. Unlike the Audigage, the Penetron does not check the condition of metal liners.

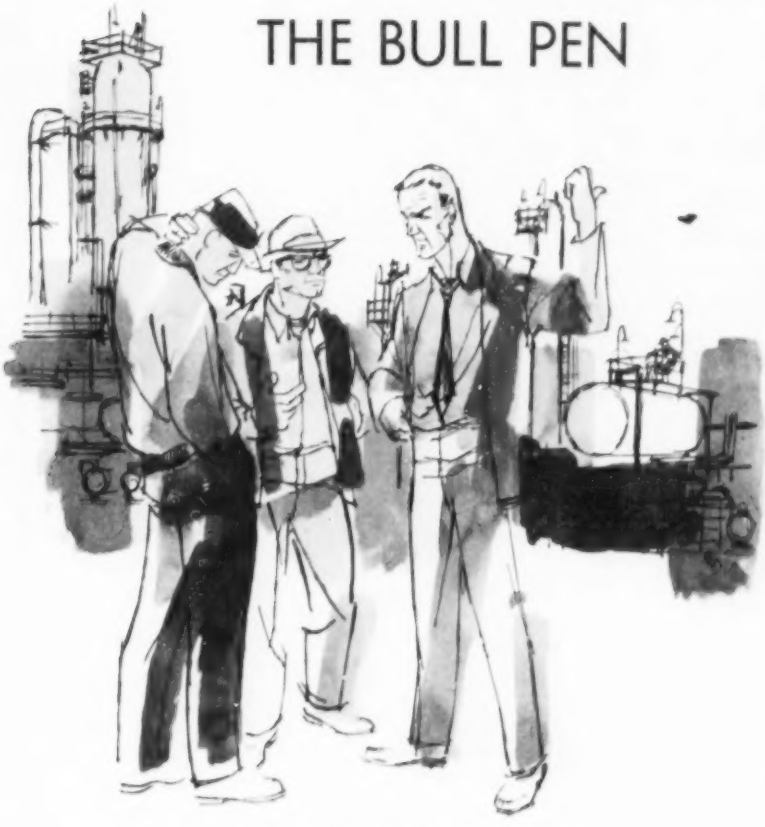
Electric resistance methods have been developed to measure wall thickness and variations in analysis and structure of materials. However, most of these are somewhat cumbersome, and more expensive than the Audigage, Reflectoscope or Penetron, and so have not found extensive use in refineries and chemical plants to date.

Radiography, the passing of X-rays or gamma rays through the metal onto photographic film, has been used on some occasions for live equipment. One example is a novel program being conducted at various refineries by the Ethyl Corp. to find the condition of welds in ethyl fluid storage tanks. The tanks are radiographed with a radioactive source on one side of the tank, and film on the other side.

Though radiography is highly specialized, and skill is needed to make and interpret the radiographs, it has the unique advantage of showing the metal loss pattern.

The "hammer-and-listen" method of judging the condition of metal is an old time technique that can be surprisingly satisfactory—if experience and good judgment are used. This method is best on pipe or vessels with a thickness of less than ⅜ in.

THE BULL PEN



"Solly, are you so short on work you can let a man sit around all day on a safety valve?"

Solly's New "What-is-it?"

SOLLY MORGAN, the operations superintendent, came storming into the Bull Pen, all out of breath. I could tell somebody was in for a bad time.

"Where's Dutch," he wanted to know. I knew what was up right away.

Solly was having a terrible time with a 3-in. relief valve on the low-pressure gas side of one of his units. That, combined with the usual day-to-day vexations of running a refinery, was about to drive poor Solly crazy.

Now, there are some people around here who will say that Solly does not have far to go, but that's beside the point—anytime Solly goes off the deep end, I'll lay odds that he'll take someone with him. This time, it was Dutch Kriger, the maintenance boss.

"Dammit, Dutch, you gotta fix that valve. I can't run a unit full of goofed up pop valves," Solly wailed.

"Now there you go, Solly—you got one li'l ol' valve that won't act right, and you make out that I've got all of 'em screwed up. Hell, that valve's got me talking to myself now."

Dutch had been fighting that safety valve for four days and he was right back where he started from. The thing kept going off at too low a pressure, and then wouldn't seat when the pressure dropped.

Seems that Solly was having his troubles trying to keep a constant pressure on the system in the first place, and that screwy valve was adding to his woes by the minute. In all fairness to Dutch, he had done everything possible, but the gas was highly corrosive—a new seat would last just long enough to let Solly settle down between pops. Then, everytime that valve went off, Solly would go off with it.

"Listen—there she goes again! Dutch, we'll never get that gas side lined out if you don't straighten out that valve." Solly was going fast by now.

Just about then, the Old Man strolled in. "Dutch, you so short on work that you can let a man sit and watch a safety valve all day? What's goin' on over on that unit?"

Solly and Dutch poured out their story.

"Well, I'll be damned! You guys are like a horse with blinders." I could see the Old Man was going into his "use yer head" lecture, so I sidled over for the education.

"If you can't find a valve that'll work, make one that will!" he said.

"Hell's bells, we're supposed to make gasoline, not valves." Solly groaned.

"That valve's on the low pressure side of the unit—right? What's the pressure there—about ten pounds? Okay, all you need is pipe and water, and you got yourself a relief valve." The Old Man waited for that to soak in. It looked like it was going to be a long wait.

"Look, one pound pressure is equal to about 28 inches of water. So, if you throw that valve away and turn the open end of the line down into a column of water 280 inches high, what do you have? A ten-pound safety valve." The Old Man was feeling good. Solly looked like he might make it.

We hustled some pipefitters over right away. Solly took the pressure off the system. Dutch had the shop make a vertical stand pipe out of 8-in. pipe with the bottom closed off with a plate. A 3-in. pipe was stuck down in the stand pipe with the open end about a foot off the bottom—the other end elled out through the wall of the stand pipe at the right height to flange up with the 3-in. gas discharge line. The inner pipe was seal welded to the stand pipe where it came through the wall. Then, a water hose connection was welded into the bottom of the 8-in. stand pipe and a small hole cut in it exactly 280 in. above the open end of the 3-in. gas line.

The whole thing was carted over to the unit and tied in. A hose was connected and the stand pipe filled until water ran out the hole on the upper end. Solly decided to let the hose run a little—as long as he could see water running out of that little hole, he knew he had a seal on that gas system.

A few weeks later, Dutch caught Solly in the Bull Pen. "Solly, I think I've found a valve that'll stand up on that gas system."

Solly was good at sharp answers, "Dutch," he said, "I've got a valve that'll handle that gas. You stay away from my unit."

Last time I noticed, that "valve" was a permanent installation—steam traced and painted.

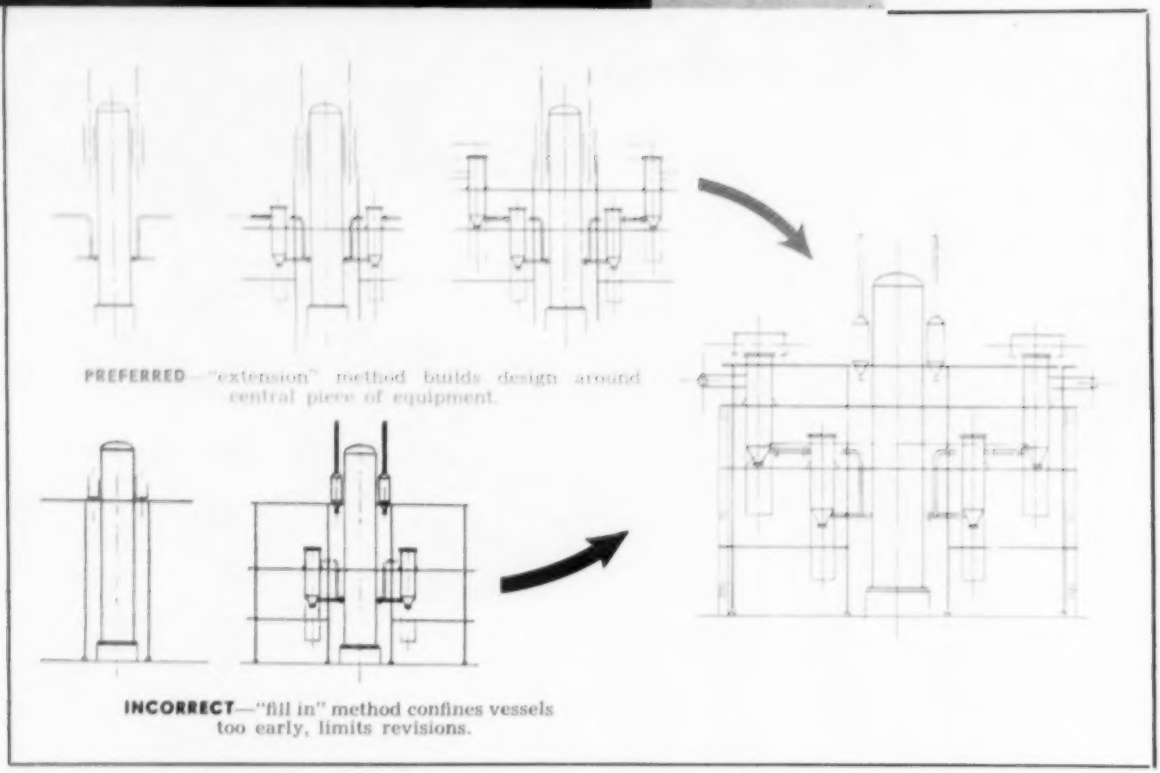

PREFERRED—"extension" method builds design around central piece of equipment.
INCORRECT—"fill in" method confines vessels too early, limits revisions.

Fig. 13—**TWO DESIGN APPROACHES** are possible on any problem. Pick the best approach as one of your . . .

Tricks at the "Board" to . . .

Increase Your Drafting Production

By ROBERT KERN
London, Great Britain

This series began in the July issue of PETROLEUM PROCESSING with an article on the physical aspects of drawing room production. It described how best to use time by proper choice of tools and methods. Last month's article suggested ways in which the designer's mental efficiency may be improved.

This month the author discusses the methods available for presenting design information in technical drawing form.

ENGINEERING drawings may be presented in many ways. But the most effective method involves a minimum of lines, symbols, abbreviations, sections, elevations, details and notes.

A technical drawing is really a short-hand method of presenting information for the design, fabrication and construction of an object or complete plant. The easier it can be read by those involved, the better it is. But it must present all information required.

The symbolic language used in engineering drawing is basically simple, although it may look complex because of the great amount of information presented simultaneously. Such an abundance of information is apt to be confusing, just as is the first sight of an actual processing plant, with its maze of piping and structures of many different sizes and shapes.

But even a complex looking plant is simple when broken into its elements. Pipes are generally parallel with each other, and their main lanes parallel with the ground and unit limits.

Branches and turnings are usually perpendicular to the main runs of pipe. structural steel outlines are boxlike arrangements, with parallel columns, and rectangular members, and process vessels and equipment also resemble basic geometrical forms when their appearance is studied.

Consequently, the most intricate line in a plant can be represented by a drawing and projected into one of three viewing planes. The symbolic methods of presenting these views for design, fabrication and erection are what we call drawing presentation.

But before a designer can sit down and create a technical drawing he must do some preliminary planning. Or he will find not only his work but that of the entire drafting room will be inefficient and costly. Good drawing presentation has two purposes: speed in executing the drawing, and speed in using the drawing. Both are the result of careful planning before physical production of the drawing.

Translating ideas into technical drawings requires more than a pen or pencil. It involves engineering know-how, 3-dimensional visualization, an appreciation of how final drawings are used—plus a knowledge of geometry.

If a designer knows all of these things, he can then select the best method for presenting his ideas on paper. If he selects correctly it means efficient drawing production, good equipment fabrication and smooth field construction. If he doesn't, it means extra trouble and cost all along the way.

Here is what is involved in presenting engineering ideas on paper.

Engineering Know-How Is Required

The first requirement for making a good drawing presentation is engineering know-how. A poorly organized design is much more difficult to present on paper than a good one. But even a good design can be presented poorly if the engineer doing the drawing does not know how to translate his thinking into pictures adequate for fabrication and field erection.

Engineers with little drawing experience will have difficulty in three-dimensional visualization of an engineering idea. Many ideas seem good when described verbally or in writing, but the first practical proof of their usefulness comes in the drawing.

Although engineering know-how is closely associated with drawing presentation, it is advantageous to make a clear distinction between engineering design work and its presentation on paper. A piecemeal approach, using little calculation and little drawing, is a slow method of designing. It is more effective to concentrate on a narrower field instead of changing repeatedly from the drawing board to the slide rule. Sketching is often required during design calculation but it should be done schematically and quickly. Then when all design data and solutions have been obtained a reasonable production can be expected on the drawing board.

A simple design and layout means not only economy in fabrication, erection, operation and maintenance but also in the production of the original design drawings.

Basic design requirements which aid efficient drawing production include placing plant equipment in repeating groups and in symmetrical arrangement where possible; the use of standard equipment, standard details, equal spacing and dimensioning; parallel pipes, structures and equipment; and coordination of piping and structural design with equipment and building location.

Plan Basic Details First

Before a line of the finished drawings is made some fundamental decisions are required to assure drawing efficiency. One of these is the determination of the proper scale.

For economic use of the paper, space on it should be conveniently and neatly filled. Large empty spaces are as bad as overcrowded, confusing details. Choosing the proper scale will avoid either extreme.

The scale also determines the number of drawings to be produced. Consequently, choosing the proper scale for the drawings is an important production cost decision.

Some overall layout planning will also prevent future annoyance. Mapping out lightly the spaces for the main and supporting sections or elevations of the drawings, along with space for dimensions and notes, will prevent crowding later. In oil refinery and petrochemical plant design a large amount of information is often confined to a small area; and it has to be presented clearly and legibly.

When drawing a number of different plans for a plant, it's efficient to have a predetermined compass point. This common orientation will prevent the confusion that results from having foundation drawings, structural and equipment layouts, and piping plans laid out to different points of the compass. For when this happens, the man in the field has a difficult time twisting and turning drawings in order to coordinate various layouts. And, if the same scale can be used throughout it will help tell the story quicker.

In presenting an engineering object it is useful to line up all sections and elevations in the direction of projection. If sections and elevations are arranged in the universally accepted way—right hand view on the right, left hand on the left, plan above and bottom below—the object is easier to visualize.

A main section or plan should always give the most important information about the object presented and should be carefully selected. A minimum number of secondary elevations and sections and details should be used. Otherwise draftsmen and designers may search sections and details for information that is already presented in the main plan view.

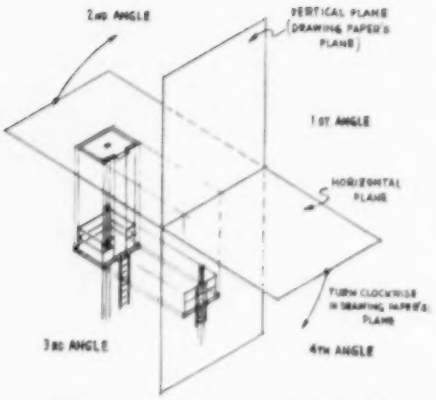
Thoughtless arrangement of details and sections may also prevent finding information quickly from the drawing. If all structural footings for individual supporting columns, for example, are presented on one drawing or grouped on one corner of a drawing, it is much better than scattering them in several locations between plans and elevations.

In preparing any drawing, thought should be given to those who will use it. These includes two main groups: those using it for reference, and those using it for fabrication and erection. When presenting design information for these two groups, different standards of draftsmanship are permissible. For supplying information only, an otherwise incomplete drawing may suffice. Because initial layouts or planning studies are coordinated information for interior-office use, they need not be exhibition pieces.

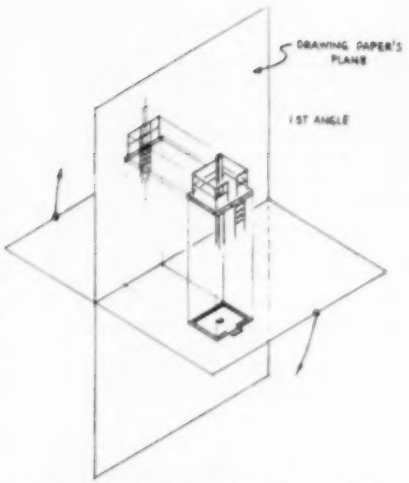
Construction plans and detail drawings, however, should be good quality —they are used for fabrication and erection outside the design office. On every drawing, engineering accuracy should be stressed, but the amount of detail depends on who will use the drawing and how much information will be required. Drawings should contain only as much information as their use requires.

To help all who use drawings, it is convenient to have a simple and comprehensive numbering system. In oil refinery and petrochemical plant design a large number of drawings are produced. A well arranged index system will shorten the route in getting information from them. A modern library has a decimal-subject system—

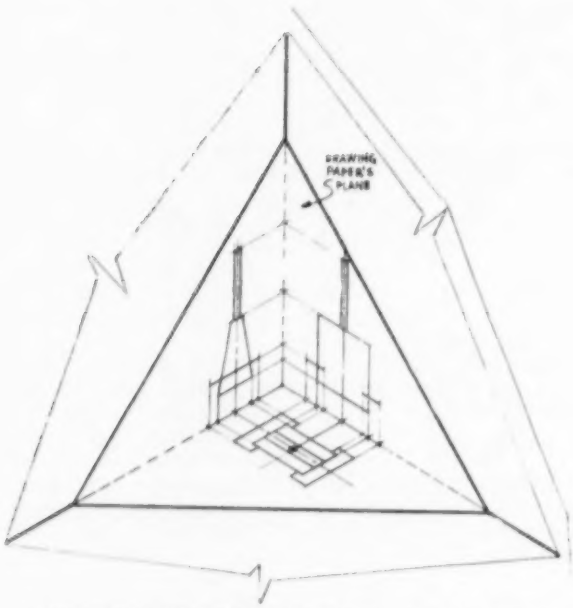
Five Ways To Present a Design —Fig. 14



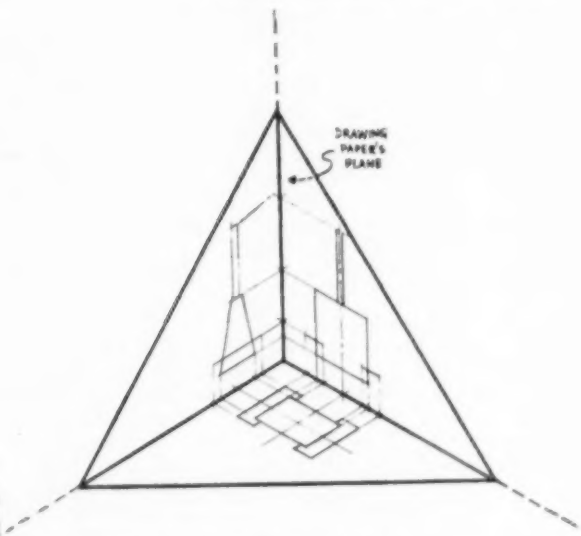
THIRD ANGLE ORTHOGRAPHIC PROJECTION—used in the United States



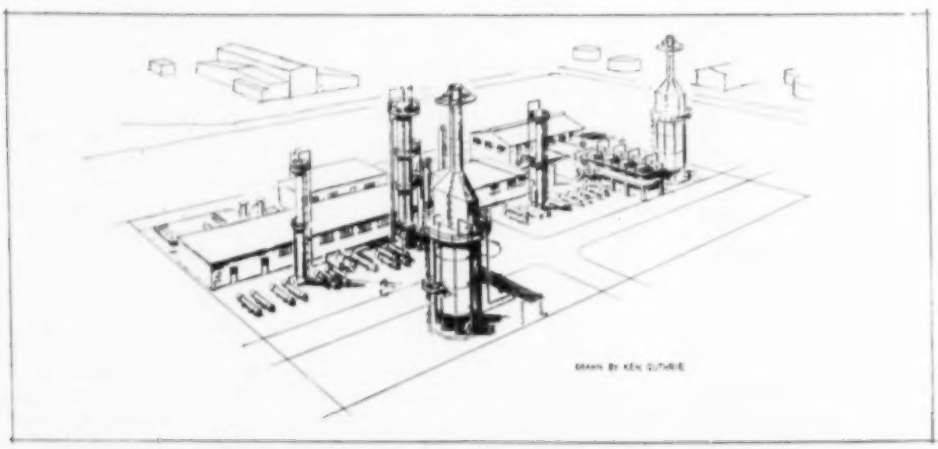
FIRST ANGLE ORTHOGRAPHIC PROJECTION—commonly used in Europe



ISOMETRIC "BIRD'S EYE" VIEW looks down on object



ISOMETRIC "WORM'S EYE" VIEW looks up, rarely used



PERSPECTIVE PROJECTION—for architectural work or special illustrations

why not the same for engineering drawings?

When a common identification system is applied to other engineering materials, such as specifications and standard drawings, the system can be learned quickly and will be easily remembered. Familiarity with a selected system is a prime requirement for following up questions in any extensive organization.

Choosing the Approach

Before a new layout is started, as much reference information as possible should be collected. Usually some freehand sketches should be produced to get the feel of the required design, because a good beginning means smooth work throughout the rest of the design and production of the drawings.

In choosing a point of attack two alternate methods are commonly used, as shown in Fig. 13. One method starts with the main piece of equipment, adding the auxiliaries around it, and leaves the structural steel for last. This ensures flexibility of design and avoids steel revisions caused by process changes.

The other method, called the "fill in" approach, is often found in design offices. Here the design is developed primarily (and wrongly) by first including the structural steel. This not only restricts design of the equipment location but may also cause many revisions later, when equipment, piping and other details are included.

Even if there is a need for early prints, the right sequence in design will produce quicker results. Layout of a fractionating column piping is an example. If the layout is started from the top of the column, there will be no trouble in dropping the large pipe lines straight down the side of the column. Then the lower spaces can be layed out with piping and nozzles, knowing what space is occupied by the large vertical pipes. But, if the design is started at the base of the column, there will undoubtedly be revisions later when it is time to drop the large pipe down from the top of the column.

A Designer Must Know Geometry

The creation of engineering drawings is executed through the application of several types of geometry—projective, plane and solid. Related trigonometry is also required.

Projective drawing is the basis of drawing presentation. Fig. 14 shows some of the alternate ways of drawing an object by projection. The most common type used is **orthographic** projection, where the center point of projection is at infinity and the projected plane (the drawing paper) is parallel to the main planes of the object.

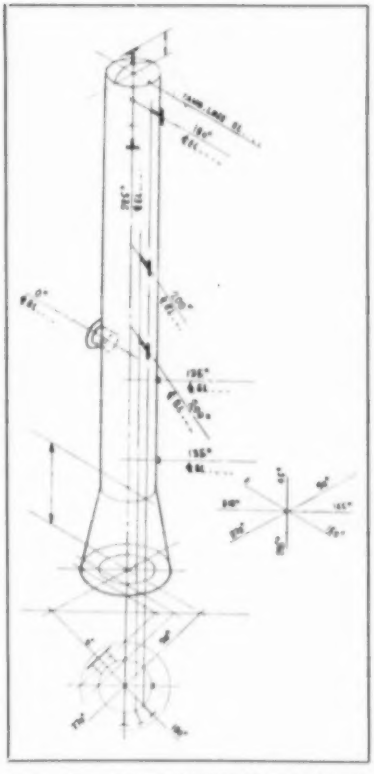


Fig. 15 — **AN ISOMETRIC DRAWING** helps give good appreciation of spatial relationships.

The disadvantage of orthographic projection is that the drawing is a superimposed picture, frequently of several planes. It is difficult to reproduce or visualize the drawn object without several sections or elevations. And, then the mind needs time to form a three-dimensional picture from the collection of flat views.

Third angle orthographic projection is used in the United States, while first angle orthographic projection is often used in Europe. A combination of both of these orthographic projections is often used, especially when an odd section has to be drawn.

Isometric projections, on the other hand, give a more realistic picture when three right-angular projected planes are visible. Projection is parallel with the intersection line of two of these planes, and for simplicity, each of these planes has the same bearing to the plane of the drawing paper. Because the axes of projection are spaced at equal angles of 120°, it's possible to use a 30° set square for drawing. The same scale is used along the three directions of projection. Although the viewer's eye is on a rectangular line to the drawing sheet, the main elevations of an object are placed parallel with the projected planes.

If the common point of the three axes of an isometric is behind the drawing sheet we have the "bird's eye" view. If this point is assumed in front of the drawing paper we have the "worm's eye" view. This last method of projection, and **perspective projection,** are not normally used for engineering drawing—except for illustration or architectural work.

How to Apply Geometry

Perhaps one of the largest fields for applying geometry is in the presentation of piping systems. For oil refineries and petrochemical plants, as many as half of the total drawings for the project may be piping drawings. Thus, simplification in piping drawings means substantial savings.

Piping drawn with a center line and two parallel lines showing the diameter, using orthographic projection, is a waste of time. Single lines are sufficient to indicate pipe runs. Piping symbols can be used extensively, and isometric fabrication and erection details can save dozens of orthographic sections and elevations. While composite orthographic plans are necessary for area piping, the most complicated single pipe line can usually be presented and dimensioned complete in one picture. However, isometric drawing is not suggested where piping is arranged in one plane, or with small elevations, which is true of yard and underground piping.

With certain limitations, structural drawings can also be presented in a three-dimensional picture for there are many simple and line-like structures. However, bulky structures, such as concrete or building designs, are best drawn and dimensioned in orthographic projection.

For vessels, external connections may be presented by isometrics in order to give a spacial picture convenient for reference (Fig. 15). The actual vessel design, with its often repeated details, is better presented in orthographic projection.

Electrical drawings with their cable layouts are similar to piping. A combination of orthographic and isometric projection is suggested.

In other sections of plant design there are only a few drawings produced. These are usually simple, and normally remain in the field of ortho-

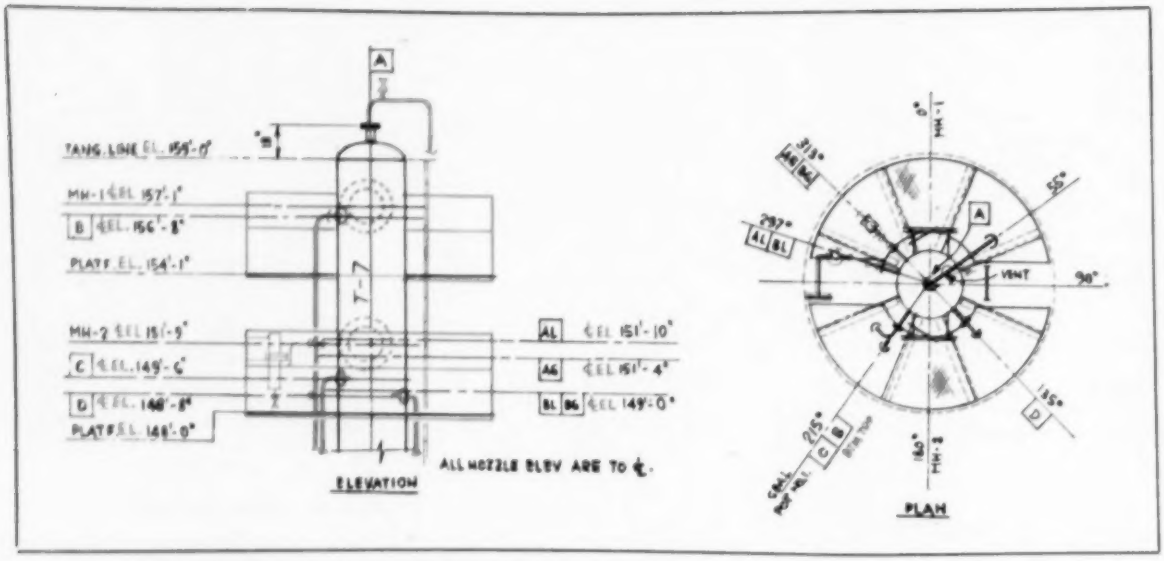


Fig. 16—**A LAYOUT STUDY NEEDS** no detailed information (indicated in color) because it is used inter-office.

graphic projection, with most drawings.

Hints for Simplifying Drawings

For effective drawing presentation, one basic to remember is that the same thing should not be presented twice. Repetition of detail does not add clarity and is a waste of time. This should be remembered by individuals and be standard practice in departments. One design group should not repeat information another has already produced.

Yard piping supports, which are included in practically every refinery, are usually dimensioned on the plot plan. Their spacing, span and identifying column numbers are defined on the plot plan and there is little reason for repeating this same information on the structural drawings. By using the plot plan as the reference drawing and plan, the required number of isometric details may be drawn. The different types of structural frames can then be identified by column numbers.

Another example of simplified drawing is shown in Fig. 16, which presents two methods of making a study drawing of the top of a fractionating column. Because a layout study is for

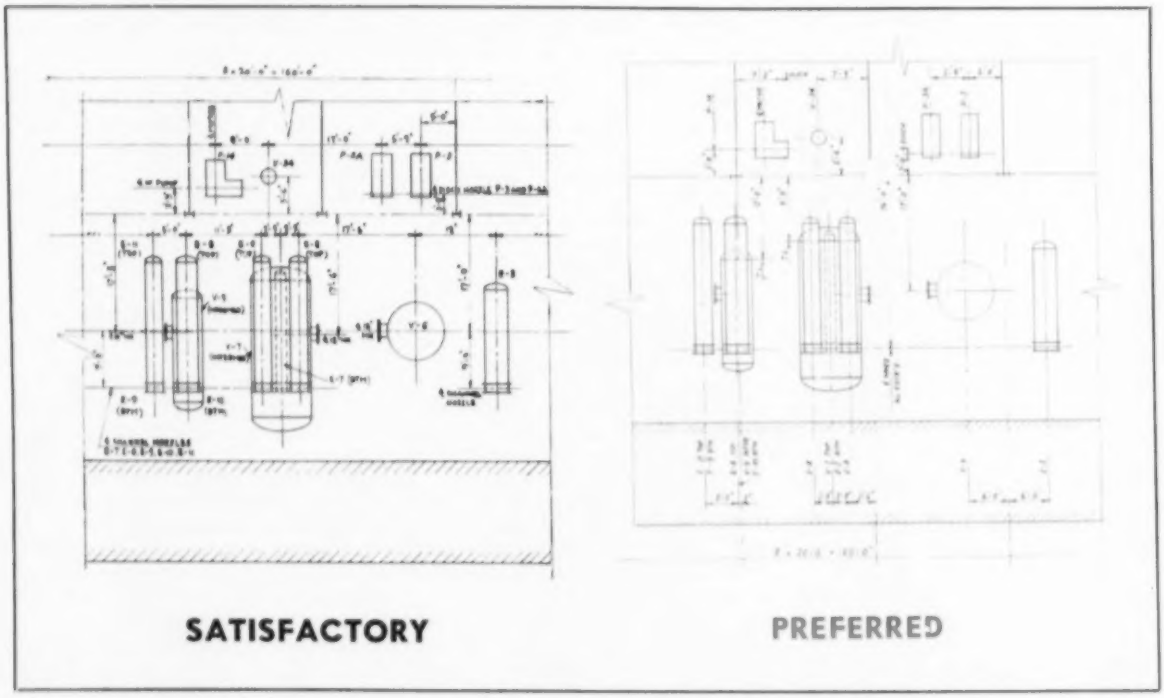


Fig. 17—**PUT DIMENSIONS OUTSIDE** the area of the drawn object for greater clarity of the object itself.

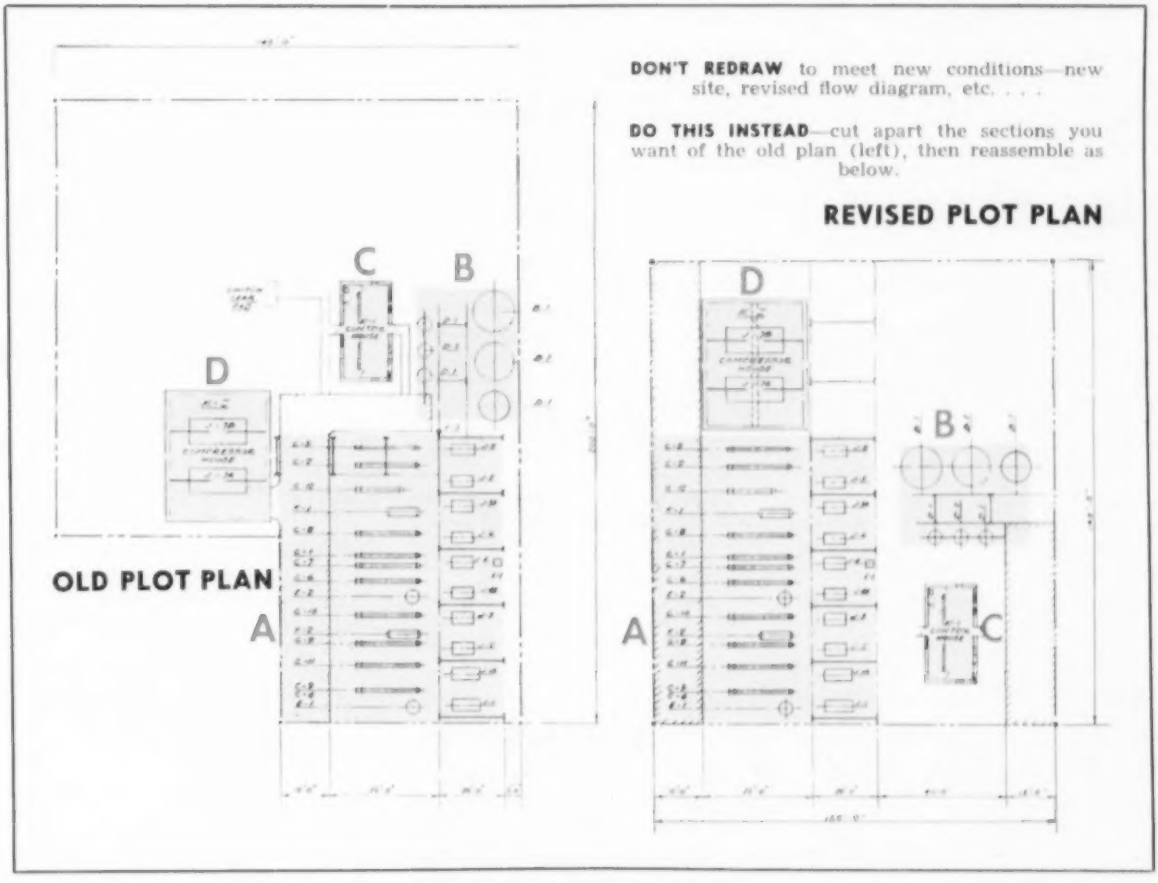

DON'T REDRAW to meet new conditions—new site, revised flow diagram, etc. . . .
DO THIS INSTEAD—cut apart the sections you want of the old plan (left), then reassemble as below.
REVISED PLOT PLAN
OLD PLOT PLAN
A
B
C
D

Fig. 18—**QUICK WAY TO A "NEW" PLOT PLAN**—revise the old one by cutting and retouching.

inter-office use and intended only for experienced draftsmen, it's not necessary to show all the extra details and lettering (indicated in color). Nozzle orientations and vertical pipe runs can be clearly presented on the plan view. Structural and equipment detail can also be omitted at this early stage of design, and an adequate drawing for study purposes can be turned out in less time.

Dimensions and written information are important parts of an engineering drawing, because they guide the men in the shop and field who fabricate and erect the object. But, as with unnecessary sections and views, repetition of dimensions and notes may confuse instead of help.

Only those dimensions having a practical and logical value in the drawing office, workshop or field should be shown. The user of a drawing should not have to go through a string of dimensions or time-wasting arithmetic before a particular measurement can be read from a drawing. tabulations of dimensions can often be substituted for repeated details, instead of repeated pictures and dimensions. Fig. 17 compares two methods of dimensioning, with the second method preferred.

If dimensions and written information are kept outside the picture itself, the drawing may be read easily. And it is best to separate dimensions into groups that interest various design groups. Pipe layout dimensions should not be included with structural steel or concrete dimensions. Piping dimensions themselves will fall into three main groups: those which locate reference lines from plant limits, those which locate process equipment from basic reference lines, and those which locate piping from equipment center lines, nozzles or tangent lines. Grouping piping dimensions this way will simplify reading the drawing.

The writing of notes and figures, as well as the preparation of material and equipment lists, are time-consuming jobs. But the use of good handwriting in this work should not be discouraged. Although appearance and legibility are essential in this work, and often require hand printed lettering, many draftsmen and designers have acceptable handwriting that can be used. And it will speed the job.

A draftsman who needs 80 minutes to write 1000 letters with a pencil lettering guide will require about 25 minutes to print the same 1000 letters freehand, upper case capital. It will take him only 10 minutes to write the same carefully by hand. This time advantage should not be overlooked.

Another lengthy, and sometimes dull job, is crosshatching sections, paved surfaces, roads and platforms. When it cannot be avoided, complete crosshatching may be replaced with partial crosshatching, labeling the words "section," "paving," "platform"; smudging (on the back of the print); or freehand crosshatching. All these are speedier ways of indicating sections and surfaces.

Many common tricks can also be effectively used for drawing simplification. Presenting half section or half elevations of a symmetrical object—or only one half of it—are well known practices in drawing offices. If several almost identical objects are to be pre-

sented it is sufficient to draw only one in detail and outline the others. If there are slight differences they can be shown on the outline drawing. Sections in two or more planes, part sections, broken sections and revolved sections provide other possibilities for saving time.

Save Time with Preprints and Reproduction

Often details, notes, titles and tabulations may be repeated on engineering drawings. Adhesive overlays or rubber stamps can save much of this repetition and still present uniform drawings.

A more advanced solution is the use of preprints, applicable when much of the equipment is identical in its appearance with only a few varying dimensions. Because it is expensive to produce a whole drawing for the sake of a few different dimensions, a preprinted drawing of the equipment (or arrangement) is the answer when tabulation of alternatives is undesirable. Then, only the required data must be inserted in the standard form.

When simple alterations are required, time can also be saved by employing proper reproduction and printing methods. This will also preserve the original tracing. One obvious method is to produce a reproducible print for an original and then alter the pencil tracing. Flow diagrams and plant arrangements can often be altered by completely cutting out details from a reproducible print and then reproducing it.

Cutting a print to suitable sections and rearranging it is another useful operation for flow diagrams or initial plot plans when elaborate dimensions are not required. Fig. 18 shows an initial plot that has been outlined for rearrangement to suit new site conditions. To produce another plot plan, the cutouts from a reproducible print were stuck together with cellophane tape. The "new" plot plan was a result of adding some lettering, retouching and redimensioning the resulting reproduction.

For sharp line definition it is advisable to place the emulsion side of the printing paper against the drawing surface. For making a copy of an already produced print, emulsion-against-emulsion will produce a better copy. Using both reproduction methods and photography, a little imagination will produce final tracings at slight cost.

Checking Is Important

Great responsibility is involved in checking technical drawings. Because this is the last step before issuing drawings for fabrication and construction, those doing the checking must have a good overall picture of the design, plus the ability to coordinate the work of several designers.

A well organized approach means more to efficient checking than physical speed. To avoid interruptions and stoppage during checking, it's best to have all reference information on hand. To ensure this, a list of reference information and drawings should be made, and an organized filing system used.

Where possible, check references should be made only between two drawings, or between the drawings of two design sections. After reference checking with the work of other divisions, the drawing itself should be checked for dimensional and design accuracy. A logical sequence of checking will enhance the final accuracy of the drawing.

Normally, a checker should not originate anything on a drawing. If major alterations are required during checking, it should be taken out of the checker's hands altogether.

The quality of the drawings sent out from the drawing office will greatly affect the fabrication and construction of the plant. The drawings will be used by many, not only engineers but craftsmen as well. Nothing should be left to the imagination of these people; the information presented in drawing form should be clear and concise.

Although efficiency in the drawing room is desirable, it is not wise to gain it by creating mistakes in the field by inadequate or confused drawings.

NEWS in VIEWS

STILL RAGING, fire which killed 19 firefighters at Shamrock Oil and Gas' McKee refinery tank farm near Dumas, Tex., destroys remains of 80,000 bbl crude tank and 10,000 bbl asphalt tank. This photo was taken morning after explosion, while refinery was shut down as safety measure.

Something New and Helpful Has Been Added to Patents

THE table that starts below is a new "added ingredient" for your monthly patents department in PETROLEUM PROCESSING.

Recognizing that tomorrow's technology is in today's patents, the Editors have completely revamped the patents listing. Our aim is to help you avoid missing out on industry plans merely because you don't know which of thousands of new patents to read.

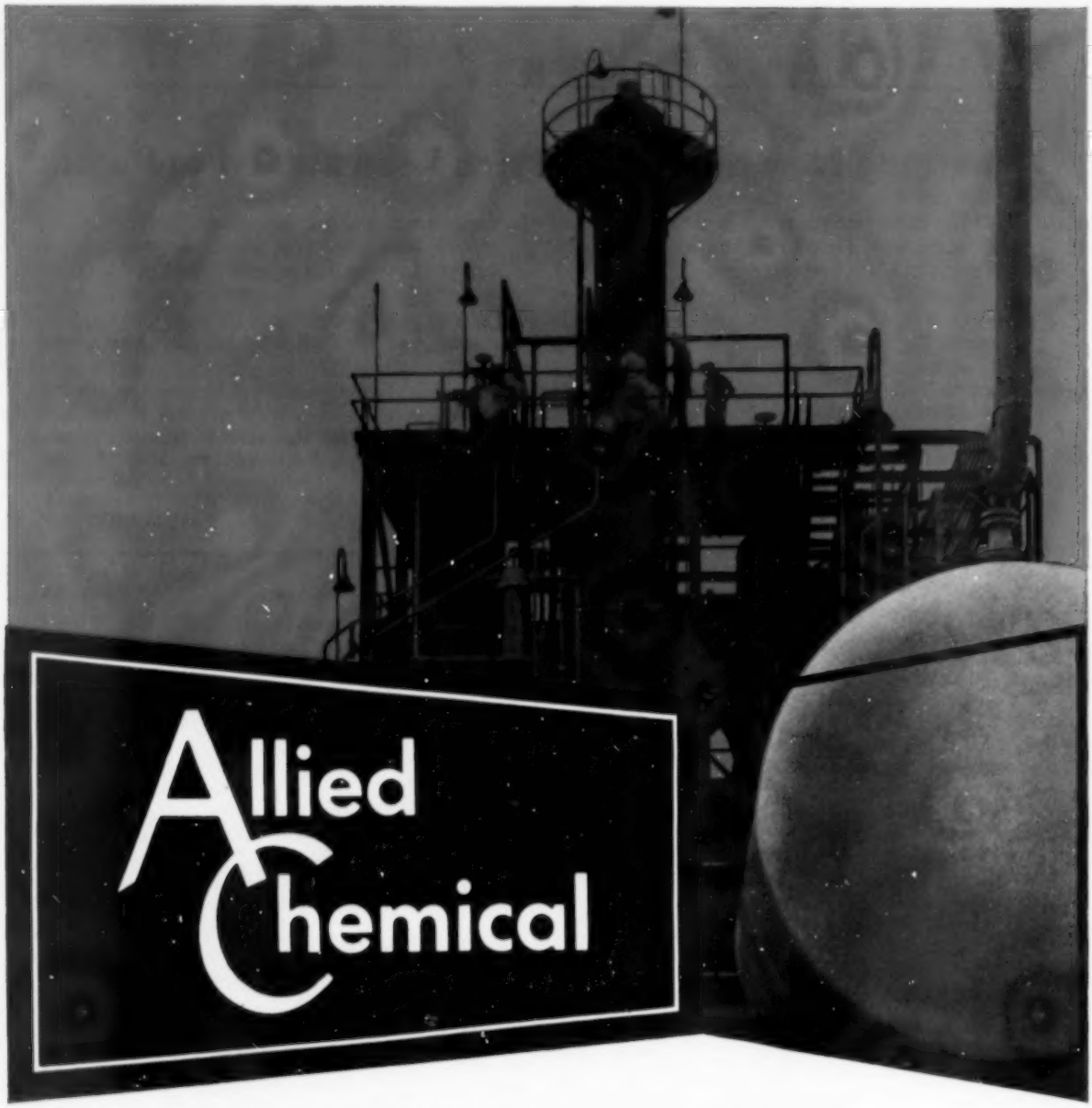
First, patents have been grouped in three major categories: Processes and Methods, Products, and Equipment. Second, individual patents are described across the page under five vertical columns. The most important single fact about any patent is its purpose. You will find the phrase telling this at the extreme left. These items are arranged in alphabetical order for your convenience.

NOTE: The regular detailed review of an important patent each month will not be omitted. Turn to p. 193 for this month's featured patent. The new listing is continued on p. 194.

PROCESSES AND METHODS

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . .
acid treatment	sour oils	aq. alkali in oil-in-water emulsion	Gulf Oil Corp.	2,753,293
adsorption	liquids	classified solids bed	Esso Research & Engrg. Co.	2,754,343
adsorption	mixed hydrocarbons	cyclic process & silica gel reactivation	Sun Oil Co.	2,754,344
alkylation	aromatics-propylene	solid H_3PO_4 cat. sat'd. with BF_3	American Oil Co.	2,754,341
	thiophenols	Al-halide cat., alkyl & alkenyl alcs.	The Texas Co.	2,753,378
co-dimerization	conjugated dienes	thermal reaction	Esso Research & Engrg. Co.	2,752,403
coking	petroleum stocks	continuous, heated retorting	California Research Corp.	2,751,334
condensing	corrosive gases	hollow discs in column	Dynamit-Actien-Gesellschaft	2,752,127
contacting	fluid streams	tower using perforated distributors	Universal Oil Products Co.	2,752,229
	immiscible liquids	contactor using jet streams	Esso Research & Engrg. Co.	2,751,335
	liquid reactants	liq. acid cat. in zoned vessel	Esso Research & Engrg. Co.	2,751,425
conversion	acid sludges	ammonia jet and neutralization	Bray Oil Co.	2,754,192
	residual oil to pitch	heated reactor	Godfrey L. Cabot, Inc.	2,752,290
	hydrocarbons	heat exchanger using pebbles	Phillips Petroleum Co.	2,752,231
cooling	fluidized solids	vaporized liq. in reactor	Shell Development Co.	2,751,756
	Oxo reactor	recycled aq. cobalt hydrocarbonyl	Esso Research & Engrg. Co.	2,754,331
copolymerization	butadiene-acrylonitrile	persulfate cat. in water emulsion	Polymer Corp., Ltd.	2,753,327
	trifluorochloroethylene-isobutylene	K-persulfate cat. in aq. soln.	M. W. Kellogg Co.	2,753,328
dechlorination	fluorochloroethane	metal agent and alcohol	M. W. Kellogg Co.	2,754,336
	reforming catalyst	washing operation	Universal Oil Products Co.	2,752,289
dehydroalkylation	unsat. bicyclic terpene	olefin & alkali metal cat.	Universal Oil Products Co.	2,754,338
dehydrogenation	paraffins to olefins dehydrogenation	water vapor & alumina-chromia-K catalyst	Esso Research & Engrg. Co.	2,754,345
	unsat. bicyclic terpene	alkali metal cat. & polynuclear aromatic	Universal Oil Products Co.	2,754,339
deoxygenation	Fischer-Tropsch diesel oil	alumina-containing catalyst	M. W. Kellogg Co.	2,752,382
	synthesized fuels	alumina-containing catalyst	M. W. Kellogg Co.	2,754,314
desulfurization	fluid hydroforming cat.	pretreater using hydrogen	Esso Research & Engrg. Co.	2,752,288
	hydrocarbon oils	perfluoraklanoic acid and BF_3	Standard Oil Co. (Ind.)	2,754,252
	hydrocarbon residues	hydrogen atmosphere to give gas oils	British Petroleum Co.	2,752,287
	light petroleum cuts	caustic soln. and pH monitoring	Pure Oil Co.	2,753,292
	Oxo alcohols	alkali reagent and distillation	Esso Research & Engrg. Co.	2,753,297
dewaxing	lubricating oils	solvent using secondary filter	Cit-Con Oil Corp.	2,754,250
elevation	granular solids	air lift in vertical line	Union Oil Co. of Calif.	2,751,257
	granular solids	gas lift conduit	Sun Oil Co.	2,753,221
emulsion breaking	water-in-oil	aliphatic dihydric alc. & ethyene oxide	Visco Products Co.	2,754,271
ethylation	acrylic olefins	organo-alkali metal catalyst	Ethyl Corp.	2,751,426
extraction	cracked gas oils	acid cation resin prior to SO_2 treat	Phillips Petroleum Co.	2,753,294
	ethylxylene in mixtures	HF and BF_3	Standard Oil Co. (Ind.)	2,753,386
	hydrocarbon oils	SO_2 & water	Houdry Process Corp.	2,754,248
	non-aromatics in oil	split feed "Duo-Sol" operation	Socony Mobil Oil Co., Inc.	2,754,247 & 249
flow control	powdered solids	feeder to higher pressure zone	Shell Development Co.	2,753,061

(Patent Briefs continued on p. 194)



ETHANOLAMINES

Treating gas with mono or diethanolamine? Allied's Orange, Texas, plant—most modern in the industry—can supply you with ethanolamines consistently above standard specifications. Shipments in tank cars, tank trucks or 55-gallon drums available from Orange, Texas. Nationwide stocks for delivery by tank truck and 55-gallon drums. Phone or write for samples, quotations, literature, technical service with no obligation.

EA 2-19-3

Allied Chemical — NITROGEN DIVISION

40 Rector Street, New York 6, N. Y.

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

Your Guide to . . . Petroleum Processing

Departments

NEW THIS MONTH

More Help from Patents

Don't miss out on what industry is planning today for possible use tomorrow merely because you don't know which of thousands of new patents to read

Your regular Patents Briefs listings have been revamped completely to help you find these patents. Turn back to **p. 163** to find what it's all about. Then turn forward to **p. 193** for the regular review. This month the featured patent is on a new coking process.

Keep Your Data File Up-to-Date

"Clip-n-File" Process Data — Synthetic Ammonia

. . . from natural or refinery gas, by the M. W. Kellogg Process, complete process information. **p. 169**

"Clip-n-File" Engineering Data — Fuel Cost Comparison

. . . including combustion fundamentals, typical refinery fuels, and a comparison table. **p. 181**

Practical Plant Practices

This regular helpful department this issue offers tips on heater insulation, on reducing leaks of asphalt and of ethylene, and on methods for cleaning heat transfer equipment. Adopt a regular practice of using Plant Practices. **p. 173**

Ready for the Fall Meetings?

The autumn schedule shows many important technical society conferences. Check on your favorite group's current plans. Then lay out your own program so you won't miss out on anything that can help you on your own job. **p. 199**

How Can He Stand It?

That's a 1200° F. furnace the man in the aluminized fabric suit is working in. He is showing it is entirely possible to make emergency repairs under conditions of intense heat. See What's New! for this and many more new product ideas. **p. 211**

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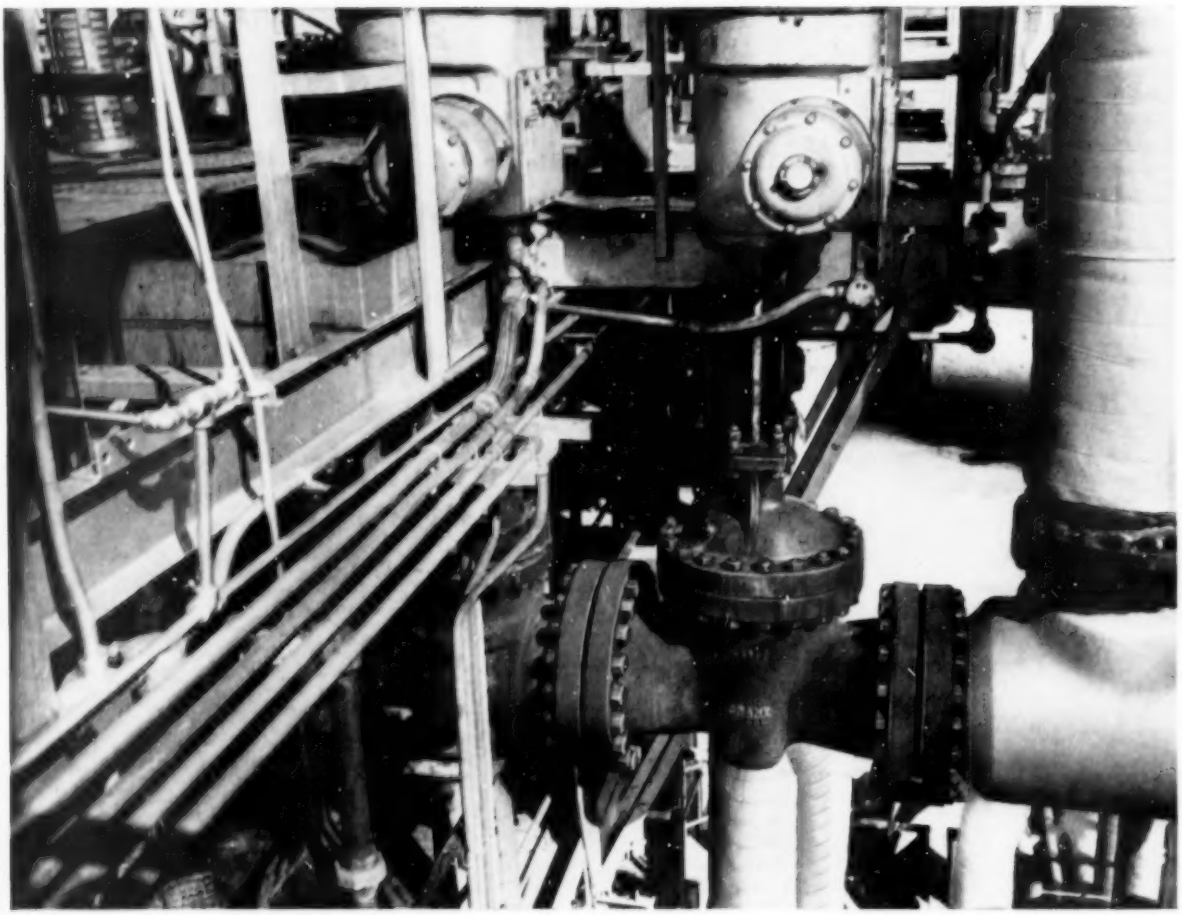

Tight, easy closure after 15 years on hot gas up to 1030° F.—with Crane valve

THE CASE HISTORY—Installed in a leading Southwest oil refinery, this Crane valve is beating its own record every day.

Since 1941, this 12 x 18-inch venturi 600-pound cast steel gate valve —with flexible wedge disc—has handled hot gas on an inlet line, from 900° F. to 1030° F. at 240 pounds pressure. It is motor-operated on a 6- to 8-hour cycle.

During the 15 years on this severe service, the *only* maintenance given this Crane valve has been routine during the scheduled unit shutdowns. The valve remains leak-free and continues to operate smoothly, with no repairs whatever to date.

This efficient flow-control operation is but one among thousands performed by Crane valves in oil refinery service—thousands of cases where Crane dependability has saved countless maintenance dollars and production time. What's back of such performance? *Proven* design—*proven* quality of materials —backed by more than a century's experience in valve development and manufacturing.

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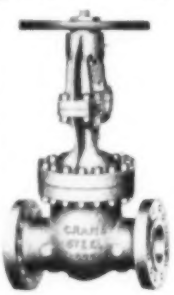

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Process—Production of ammonia by steam reforming natural or refinery gas under pressure, followed by carbon monoxide shift, purification of raw synthesis gas and ammonia synthesis.

Process Flow—Saturated and unsaturated hydrocarbons are decomposed by steam according to the basic equation:

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

This process normally is advantageous with starting materials having a wide range of methane concentration (e.g., natural gas, refinery gases and coke oven gas).

The flow diagram is representative of a number of actual commercial installations making ammonia from natural gas feed stocks.

The first step in the process is to generate raw synthesis gas. The primary reformer converts about 70% of a natural gas feed into raw synthesis gas, in the presence of steam and using a nickel catalyst.

Primary reformer effluent is then charged to a secondary reformer where air is introduced. The heat of combustion of the partially reformed gas supplies the energy needed to reform the remainder of the gas after combining with the oxygen in the air. The nitrogen from the air is needed for the subsequent ammonia synthesis cycle.

This high pressure reforming process utilizes the potential energy of the relatively high pressures at which natural gas normally is available. Although the synthesis gas must be still further compressed before charging to the ammonia converter, high pressure reforming conserves 30-40% in compressor horsepower over usual practices giving low pressure synthesis gases.

After leaving the secondary reformer, the mixture enters an integral quench vessel where a direct water quench lowers the gas temperature. The quenching brings gas temperature to the required shift reactor temperature, and makes the additional steam needed in the shift reaction.

In the shift reaction, carbon monoxide in the gas streams is converted to carbon dioxide, and simultaneously makes hydrogen (a result of the reaction with steam).

Shift reactor effluent, after heat recovery, is cooled and compressed, then goes to the gas purification section.

Carbon dioxide is removed from the synthesis gas in a regenerative MEA (monoethanolamine) system. Advantages of MEA removal of carbon dioxide are: no oxygen contamination, negligible synthesis gas loss, essentially complete removal of carbon dioxide, compactness of equipment, and production of pure carbon dioxide usable to make dry ice or urea. Water wash scrubbing can be used, if preferred for local reasons.

After carbon dioxide removal, carbon monoxide traces left in the gas stream are removed by scrubbing with a regenerative cuprous ammonium acetate solution.

The resulting pure synthesis gas passes to the oil separator, where it mixes with a recycle stream cooled with ammonia refrigeration, and goes to the secondary separator where anhydrous ammonia (contained in the recycle stream) drops out.

Synthesis gas is then passed through heat exchange and charged to the catalytic ammonia converter. Product gas from the converter is cooled and exchanged against converter feed gas.

Anhydrous liquid ammonia then separates out in the primary separator and, after further cooling by ammonia refrigeration, goes to the anhydrous ammonia product flash drum.

Catalyst—Reforming is with a nickel catalyst that is temporarily poisoned by sulfur compounds. Therefore, essentially complete removal of sulfur from the feed gas is needed. Catalyst activity can be restored by exposure to sulfur-free gas.

Shift reaction is with an iron oxide catalyst insensitive to sulfur compounds or other components normally found in crude synthesis gas.

Ammonia synthesis uses a promoted iron oxide catalyst that is poisoned by oxygen and sulfur compounds.

Operating Conditions—Pressure of the reforming process can handle natural gas in excess of 200 psig. Temperatures in primary and secondary reformers are 1400-1800°F, while shift reaction temperatures are 700-850°F.

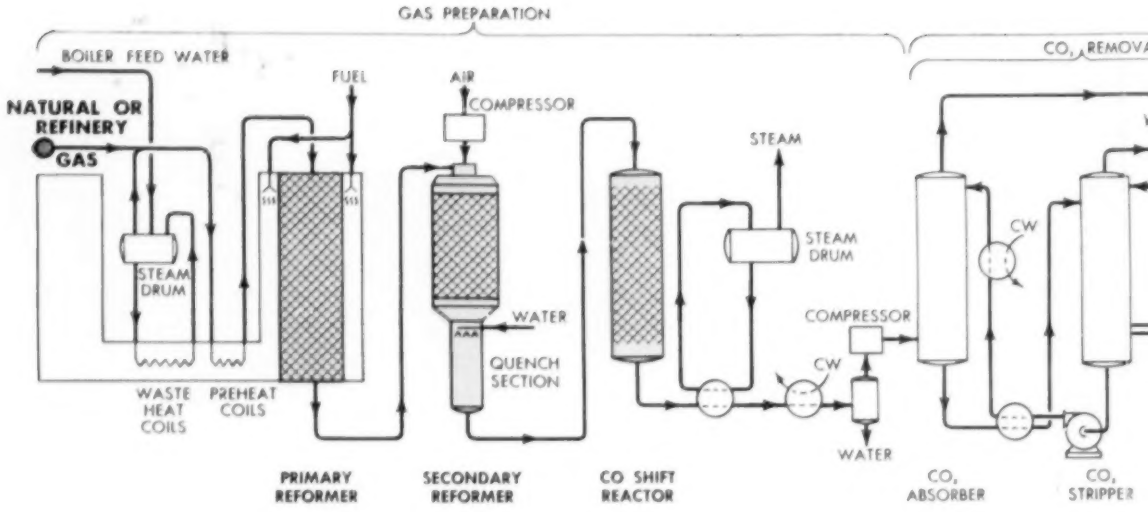
Ammonia synthesis is normally at 4700 psig, but the converter can be designed for somewhat lower or higher pressures when required.

Equipment—The "quench-type" ammonia converter was developed by Kellogg. Temperature is accurately and flexibly controlled inside the catalyst mass to allow a catalyst basket temperature gradient giving a maximum yield of ammonia per pass, regardless of production rate. Hot spots, common in catalyst baskets having tubular heat exchangers, and a cause of catalyst activity deterioration, are eliminated by the reactor's approach to isothermal conditions. The design thus favors long catalyst life, low maintenance cost, and high conversions.

Utilities—The following consumptions of utilities and raw materials are typical of a unit making 300 tons per stream day of anhydrous liquid ammonia.

Natural gas feed*	6.0 MM SCFD
Natural gas fuel**	3.3 MM SCFD
Electricity	10,800 kw
Cooling water (85-110°F)	12,700 gpm

*Based on lower heating value of 1000 Btu/SCF
**Net fuel needed, including boiler plant



Economics—For 300 t/sd (and 104,000 t/calendar yr) ammonia production, investment and economics are shown in the accompanying table.

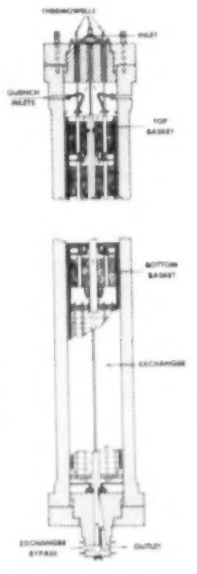
Installations—During World War II, Kellogg built three major ammonia plants using conventional low pressure reforming. Since that time, the following plants have been built, or are under construction, using high pressure reforming: Shell Chemical Company, Ventura, California, 150 t/sd; Standard Oil Co. of Ohio, Lima, Ohio, 300 t/sd; Standard Oil of California, Richmond, California, 300 t/sd; Northwest Nitro Chemicals, Ltd., Canada, 100 t/sd; and Potasse Et Engrais Chimique, S. A., France, 110 t/sd. In addition, one plant has been built for National Distillers Products Co. at Tuscola, Ill., to produce 150 t/sd ammonia using nitrogen wash on a hydrogen rich gas.

Licensing—No licensing arrangements are needed for the plant described. Engineering, design and construction of this type plant are available from the M. W. Kellogg Co., 711 Third Ave., New York City.

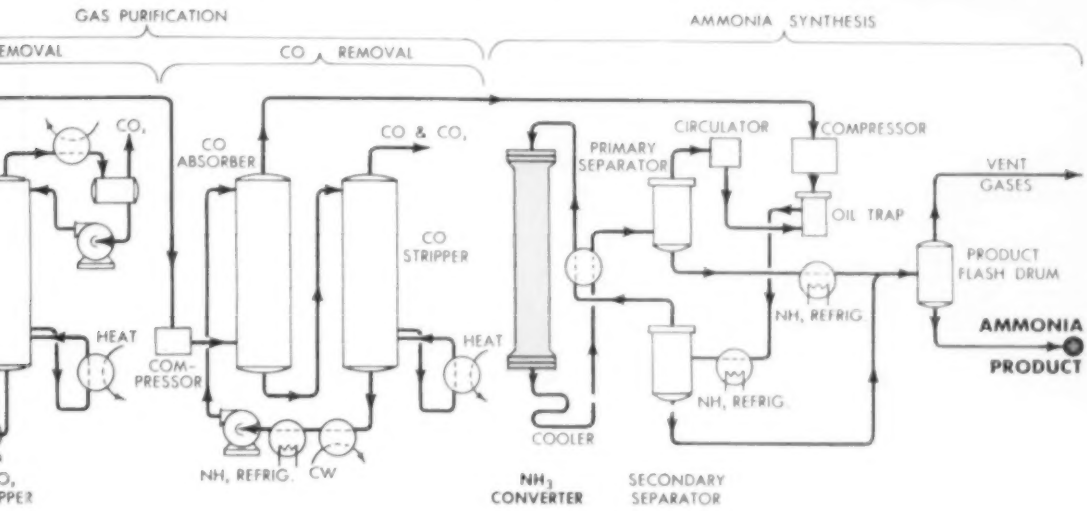
Economics for anhydrous ammonia plant—300 tons/stream day and 104,000 tons/calendar year

(Estimated investment—$7,000,000)

Raw materials	Unit	Unit Price	Unit/ton NH_3	Ammonia Cost $/ton	$/year
Natural gas feed	MMSCF	$0.35	20.1	7.04	731,000
Utilities					
Natural gas fuel	MMSCF	$0.35	11.1	3.89	405,000
Electricity	kwh	$0.005	864.0	4.32	449,000
Cooling water	M-gal	$0.01	61.0	0.61	63,000
Catalysts	——	——	——	0.46	48,000
Chemicals	——	——	——	0.18	19,000
Labor					
Supervisory	——	——	——	0.59	61,000
Operating	Man-days	$54	——	0.94	98,000
Benefits (21% of supv. + oper.)	——	——	——	0.32	33,000
Sub Total				18.35	1,907,000
Fixed Charges @ 11% of Investment	——	——	——	7.41	770,000
Total costs before depreciation	——	——	——	25.76	2,677,000
Depreciation @ 10% of investment	——	——	——	6.71	700,000
Grand Total Cost				32.47	3,377,000
Total ammonia credits	ton	$80	1	80.00	8,320,000
Net ammonia credits, before taxes	ton	——	——	47.53	4,943,000
Net ammonia credits, after taxes @ 50%	ton	——	——	23.76	2,471,500
Payout after taxes (incl. depreciation)	——	——	——	2.0 years	
Cash return per year after taxes (excluding depreciation)	——	——	——	35.3%	



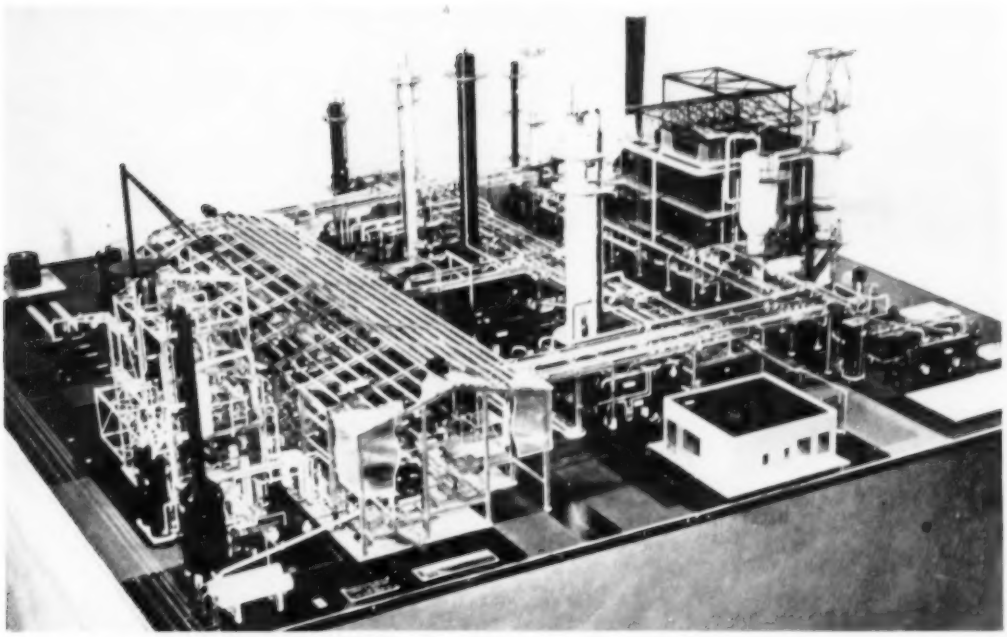
QUENCH TYPE AMMONIA SYNTHESIS CONVERTOR



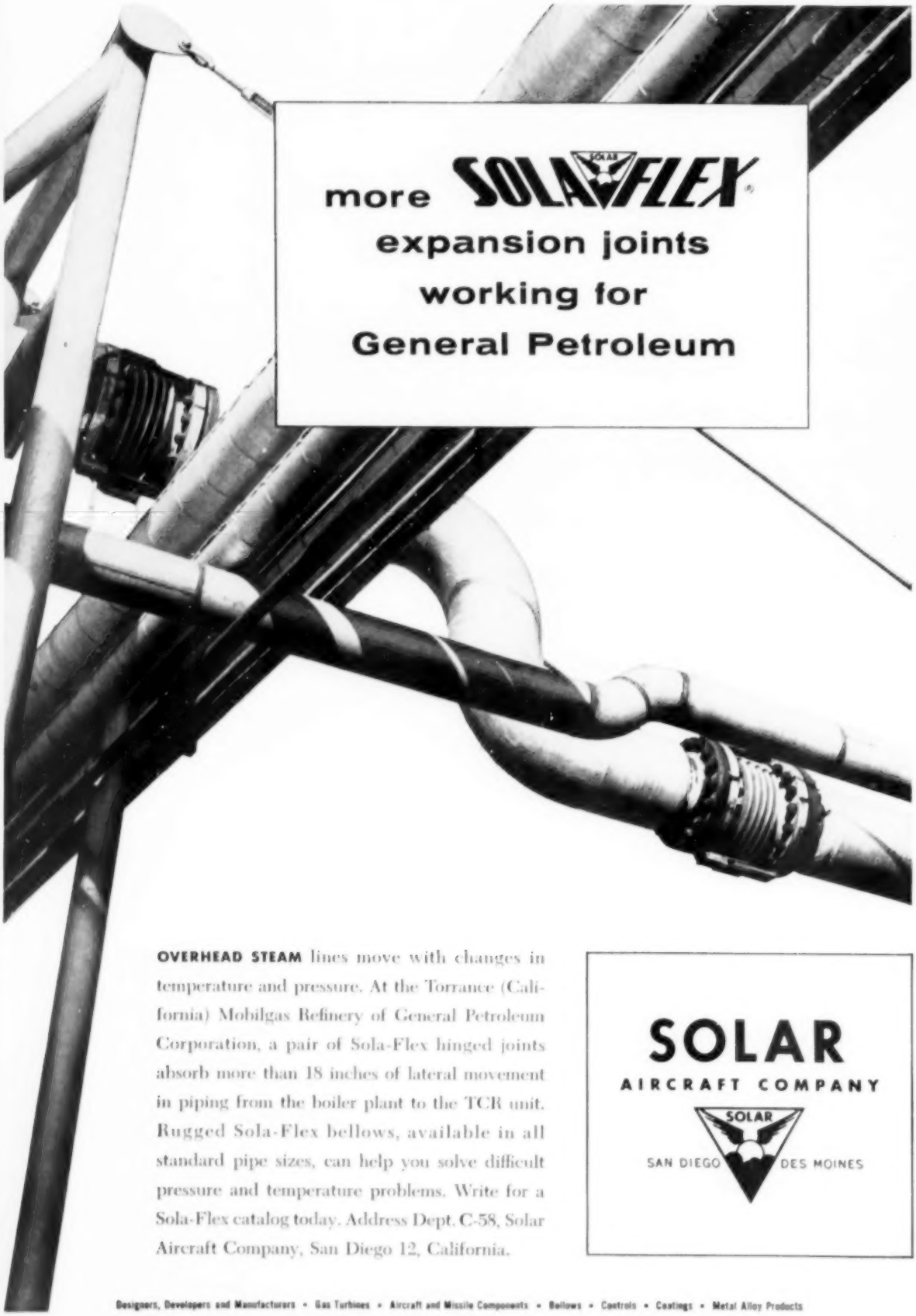
Synthetic Ammonia

From Natural or Refinery Gases

UNFOLD **FOR START OF PROCESS DESCRIPTION**



SYNTHETIC AMMONIA PLANT MODEL for Sohio's Lima, Ohio, petrochemical plant



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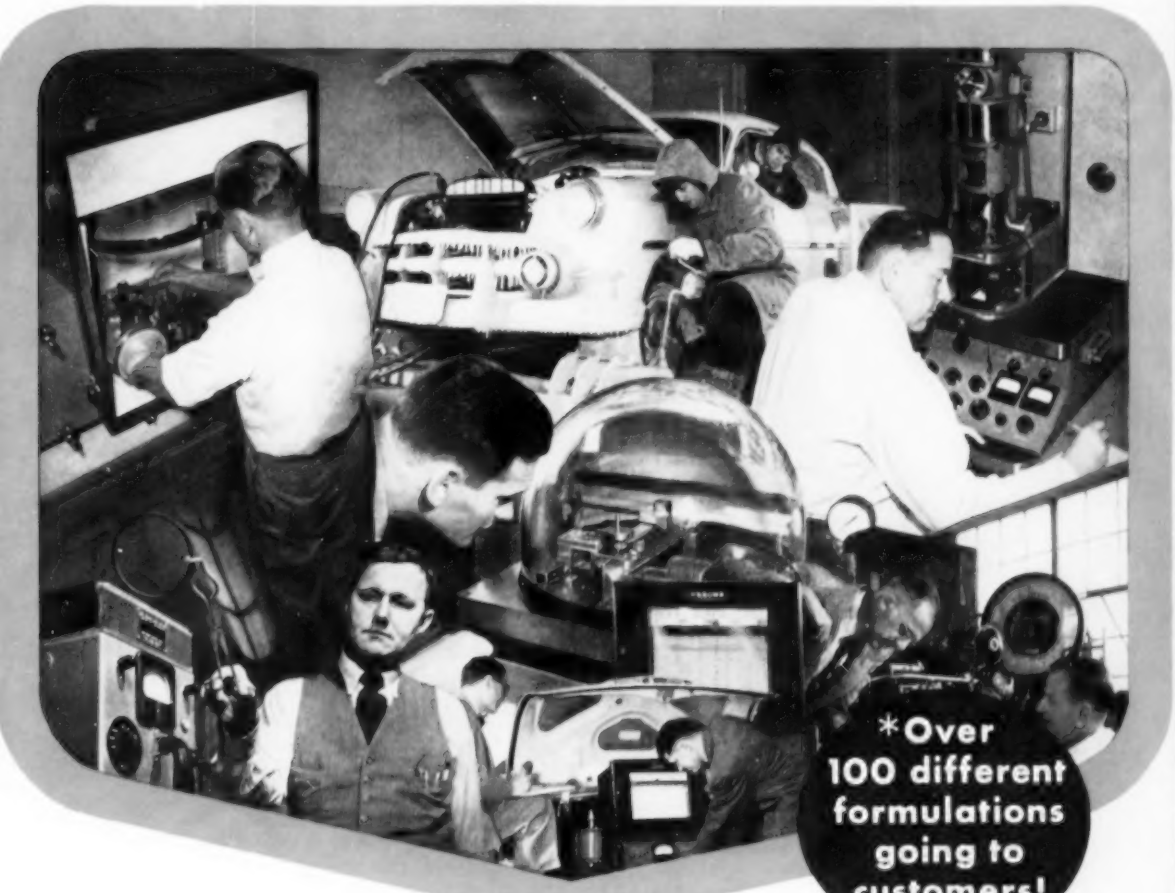

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Are You Insulating a Heater?

THERMAL insulation serves two purposes in fluid heaters: it insures thermal efficiency by minimizing heat loss, and it prevents the heater casing from becoming hot enough to be a hazard to operating and maintenance personnel. When hot face temperatures reach 1200 to 1600°F in the inner insulating material, proper insulation installation is necessary. The drawing shows one method of economically installing insulation.

Structural steel sections of the shell are prepared for the insulating material by attaching lengths of ⅛-in. diameter wire, stud or tack welded at one end to the interior face of the casing. The free length of the wire is ½-in. shorter than the total thickness of the insulating block.

Before any of the blocks of insulation are applied, a 1/16-in. coat of asphaltic mastic is applied to the inner surface of the shell. This mastic (1) prevents corrosion due to condensation of corrosive products of combustion when the shell temperature is low or the heater is idle, and (2) provides an adhesive surface for the first layer of mineral wool block insulation.

The first layer of block insulation is impaled on the wire studs, which have been bent down and out at a 90° angle. As soon as the first layer has been built up a sufficient distance from the bottom around the interior of the wall, the second layer of block insulation is applied.

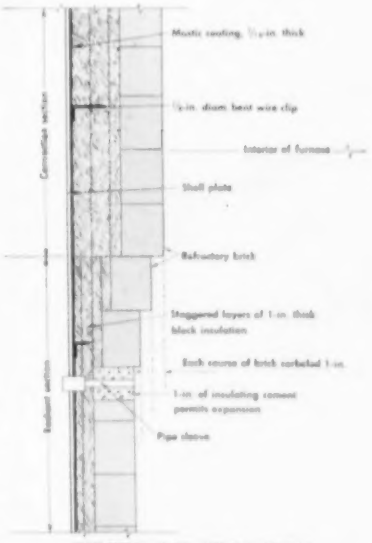
The wall of refractory brick is laid as soon as the second course of insulation block has progressed a short distance up the wall of the furnace. As shown, each course of brick is corbeled inward in one-inch steps until the desired reduction of annular space is reached at the top of the radiant section. After the desired reduction the brick wall again ascends vertically. Layers of insulation blocks are also impaled on studs in the convection section.

This technique of entirely filling the wall-to-shell space is more economical than stepping the outward shell inward and maintaining the same thickness of insulation.

To permit differences in thermal expansions of pipe sleeves (for thermocouples or draft gages) and the refractory, mineral wool insulating cement may be used. Because it retains plasticity after setting, a one-inch layer allows the pipe and refractory to expand.

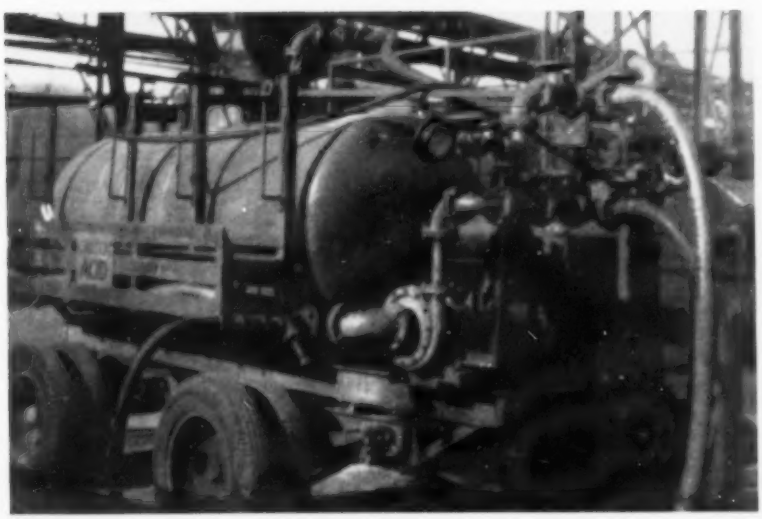
In heaters developing temperatures greater than 1600°F on the inner face of the refractory brick, four inches of block insulation and either one or two layers of refractory brick are usually specified. In installations where the brick does not bear directly against the mineral wool block the wire studs must be long enough to bend back over the block surface.

Sometimes, insulating cement may be used between the block insulation and the refractory brick. Then, the cement is placed in lifts of not more than 6 or 7 ft high at one time. And it's not packed tightly or vibrated into place, to avoid hydrostatic pressure.



CROSS-SECTION OF INSULATED FURNACE WALL

Cleaning Tank is Rubber Lined



CLEANING condensers and other equipment with acids and chemicals is efficient. But extreme activity of the chemicals normally means a short life for the cleaning tank and accessories. The engineering department at Shell Oil Co.'s Wood River, Ill., refinery, however, has found a way to reduce the corrosion on its chemical equipment. The solution? A rubber-lined tank with rubber-lined pipe and valves.

The tank, a 1000-gallon steel structure with a ¼-in. rubber lining, is mounted on a trailer. An alloy, centrifugal pump driven by a 2-cylinder, 12-hp gasoline engine is mounted on an extension of the same trailer. This portable equipment is used almost daily for acid cleaning of condensers throughout the refinery, and replaces an unlined steel tank, which used to require extensive maintenance.

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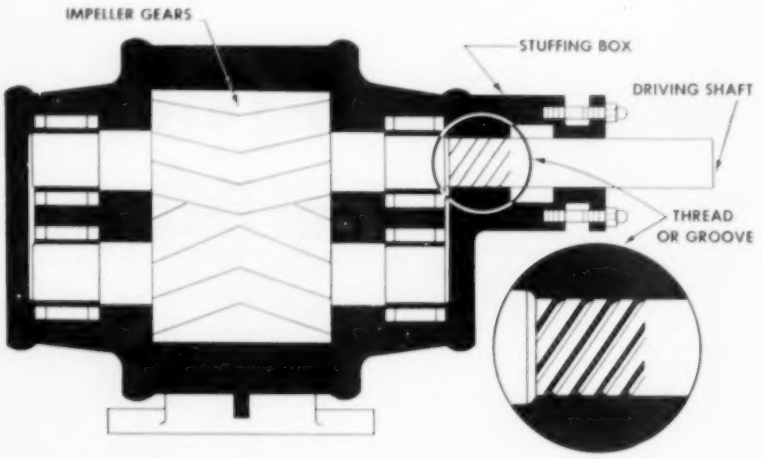


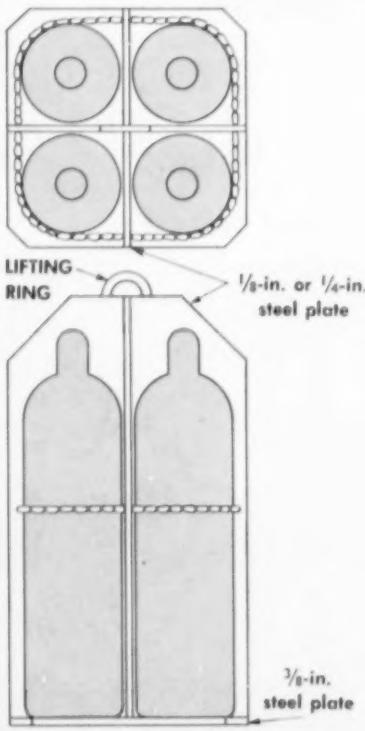
Grooves Cut Asphalt Leaks

LEAKING asphalt pumps not only are messy but also contribute to the loss-and-profit figure. But Phillips Petroleum Co.'s Kansas City, Kansas, refinery has found a way to prevent the extrusion of messy asphalt "ropes" past the packing gland.

A spiral groove, with a configuration similar to an Acme screw thread, is cut into the pump shaft. The groove is in the three-inch portion of the shaft which is positioned in the pump side wall. When the drive shaft is turning, the grooved threads (cut opposite to the direction of shaft rotation) divert the asphalt back into the pump stuffing box.

Phillips reports that this revision on the asphalt rotary gear pump has appreciably reduced the amount of asphalt leaking past the packing gland.

This idea was an award-winning suggestion by R. W. Logan of Phillips Petroleum Co.'s Kansas City, Kansas, refinery.



4-BOTTLE CARRIER

Steel Bottle Holder Permits Safe Handling

A SAFE AND efficient method for moving steel bottles of oxygen and acetylene for welding, to and from the job and around the job site, has been developed by maintenance personnel of Cosden Petroleum Corp. at Big Spring, Texas.

Bottles are stored by Cosden, as by most plants, in a separate building, far removed from the plant shops and process areas. Only enough gas for current work in the main shops or at construction and repair sites is brought in—and then only as needed. Handling the steel bottles safely is strenuous. They're tied down during transport to prevent their shifting or being knocked or pulled over.

Cosden's welders developed two types of carriers, holding either two or four cylinders. The two-bottle model is used at the work-site and can be easily picked up by a hoist-truck without disturbing cylinders or hose connections. The four-bottle model is used for bringing fresh cylinders to the job-site and removing empty ones.

The carriers are made of steel

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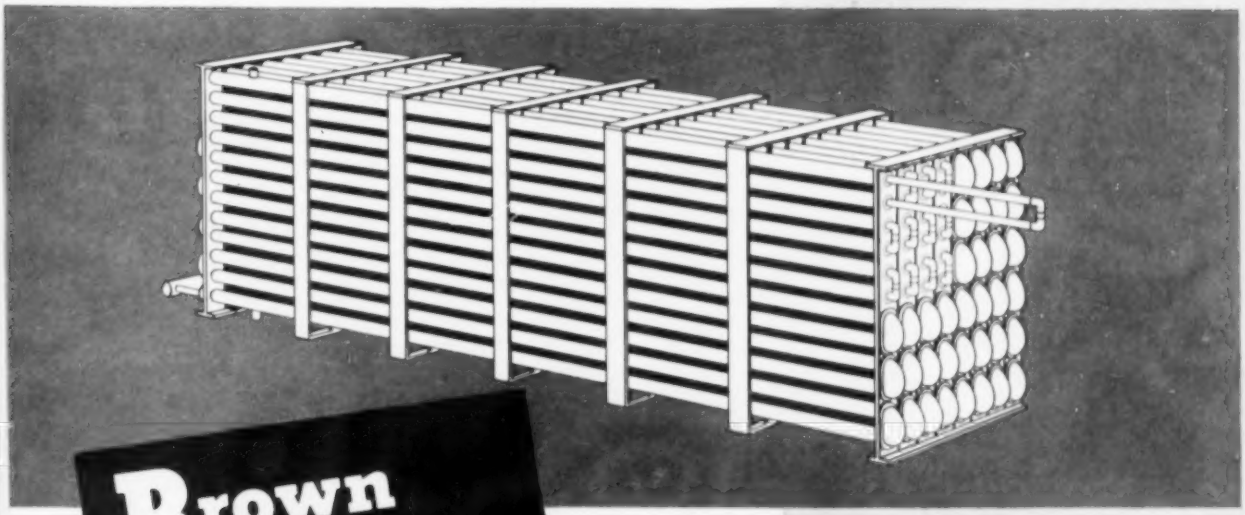

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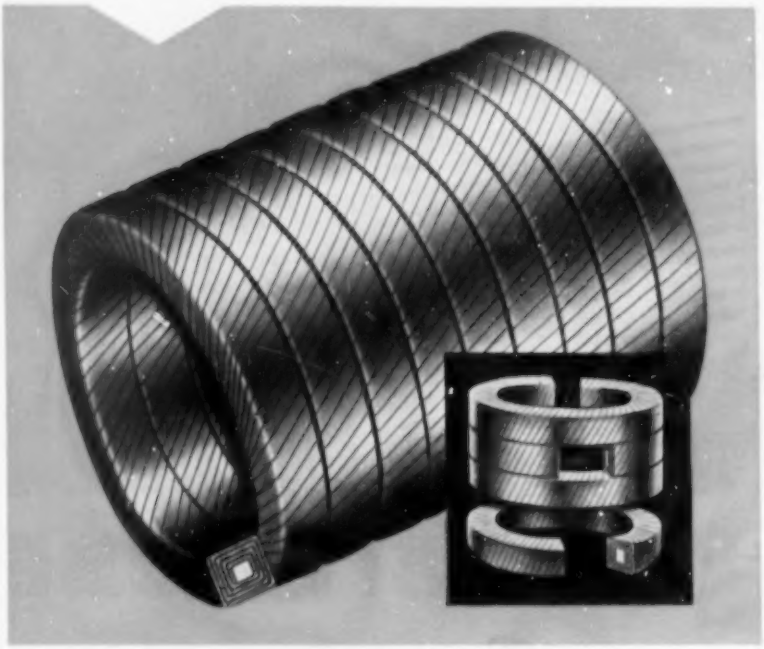

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plate. Three pieces, somewhat longer than a cylinder with its protective cap, are welded together at right angles. A lifting ring is welded at the top intersection. The bottom edges of the three plates are welded to another plate that forms the flat bottom of the carrier.

The two-bottle model is similar to the four-bottle model, except it has just one vertical member. In both carriers, the bottles are bound to the frame by steel chains that encircle the outer part of each gas container.

Tinned Threads Prevent Ethylene Glycol Leaks

AROUND a refinery ethylene glycol is used as an anti-freeze in more than just automobile radiators. A common use is as an all-weather sealing fluid in seal pots and meter runs for flow meters. But any pipefitter aware of this use knows how hard is is to prevent ethylene glycol from leaking through threaded connections. Ordinary thread compounds and pipe-fitting care are not enough.

The problem has been solved at the Gladwater, Texas, gasoline plant of the Warren Petroleum Corp. All the meter lines and connections were dismantled and cleaned thoroughly. The threads of all connections were then tinned with ordinary soldering wire, and the meter lines holding the ethylene glycol were reassembled. Since being put back into service, the connections have remained tight and no leaks have been found.

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For further information, send for our brochure describing these units, mentioning type of gas and storage requirements.

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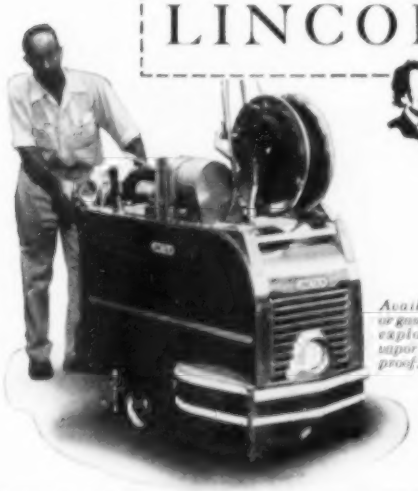

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Sodium Gets the 'Full Treatment'

Sodium, Its Manufacture, Properties and Uses, by Marshall Sittig, ACS Monograph No. 133, 1956, 6¾ x 9½ in., 529 pp., illustrated, indexed, stiff cloth cover, $12.50, Reinhold Publishing Corp., 430 Park Ave., New York 2, N. Y.

SODIUM has become a "heavy" among chemicals, as its worldwide production of 300 million lb/yr will attest. Today it is used chiefly in the synthesis of tetraethyl lead, though it is important for making detergents and certain sodium compounds—peroxide, hydride, cyanide and amide.

Sodium is finding new uses as well. In nuclear power plants it is an efficient heat-transfer medium, and it can be used to cool automobile engine valves. In organic chemistry sodium is used to prepare metal alkoxides, and it shows promise in the treatment of petroleum fractions.

The price of sodium has dropped from $2/lb in 1890 to about 16¢/lb in 1953, making it the cheapest nonferrous metal and an attractive raw material for chemical processing.

Yet, Author Sittig states, aside from reviews in chemical encyclopedias, "there is no body of technical information available to the chemist or engineer interested in sodium." This gap, we submit, has now been filled—snugly.

The book sets out to cover "all that is currently important in the manufacture, handling and use of sodium," to quote the author again. And Chapter 9 presents a critical resume of the physical and thermodynamic properties, contributed by George W. Thomson and Edward Garelis, both of Ethyl Corp.

Mr. Sittig would seem well qualified to undertake this comprehensive job for the American Chemical Society (the book is one of the ACS's series of chemical monographs). He has authored 13 technical articles on the subject and is now in sodium sales development work at Ethyl. Also, he was chairman of the symposium on handling and uses of the alkali metals at the ACS meeting last spring.

The more precise scope of his book is metallic sodium, for the nonmetallic compounds—sodium chloride, hydroxide, and carbonate, for instance—are not included.

With this in mind, then, let's review the layout of the book, chapter by chapter:

Introduction, with a historical survey of sodium and its production and use patterns.

Manufacture of Metallic Sodium, covering thermochemical reduction processes, electrolysis of sodium salts, electrolysis in solvent media, manufacture by recovery from alloys and manufacture of the alloy form.

Solubility and Alloy Formation.

Handling Metallic Sodium, including a list of the forms in commercial use and a section on safe handling techniques.

Uses of Metallic Sodium: as a heat-transfer medium, electrical conductor, physical agent in metallurgy, and other uses of its physical properties.

Inorganic Reactions of Sodium, including reactions with water, oxygen, hydrogen, halogens, ammonia, and inorganic salts. Metallurgical uses and the radioactive isotopes of sodium are also considered.

Use of Sodium in Organic Reactions has information on reactions with alcohols and ethers, organic halides, carbonyl compounds, organic nitrogen compounds, hydrocarbons, organometallic compounds, and organic sulfur compounds. Formation of cyclic compounds by ring closure, and purification of hydrocarbons are also discussed in this chapter.

The Analytical Chemistry of Sodium reviews the determination of: sodium in solution, metallic sodium, and impurities in metallic sodium. The chapter also covers the use of sodium in analytical chemistry.

The final section, 143 pages long, contains a thoroughgoing examination of sodium's physical and thermodynamic properties. Mr. Thomson is supervisor of Ethyl's physical data group. Mr. Garelis is a chemical mathematician.

Book Briefs

Petroleum and Natural Gas, by R. A. Cattell and others, a preprinted chapter from Bulletin 556, *Mineral Facts and Problems*, Dec. 1955, 8 x 10½, 80 pp, illustrated, paper cover, $0.75, U. S. Bureau of Mines, obtainable from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

. . . a thumbnail description of the industry and its products, including petrochemicals. Covers history, technology, organization, and future prospects of oil production, transportation, refining, and exploration. Treats self-sufficiency question, conservation, research, and other topical problems.

Chemical Safety Supervision, by Joseph Guelich, 1956, 221 pp, hard cover, 6 x 9 in., illustrated, $4.50, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

. . . a plain-spoken book for chemical supervisors that shows what accidents can happen and tells, in practical terms, what the supervisor can do at every stage of chemical plant operations.

1955 Vacuum Symposium Transactions, 1956, 101 pp, cloth bound, 9 x 11½ in., $10, published by Committee on Vacuum Techniques, Box 1282, Boston, Mass.

. . . from the meeting at the Mellon Institute in Oct., 1955. Book is divided into four categories: Fundamental Developments in Vacuum Technology, Methods and Techniques for Obtaining High Vacuum, Vacuum Systems Applications and Processes, Standards and Nomenclature.

Electric Generation—Hydro, Diesel, and Gas-Turbine Stations, Bernhardt G. A. Skrotzki, ed., 1956, 458 pp, cloth bound, 6 x 9 in., $8.50, McGraw-Hill Publishing Co., 330 W. 42nd St., New York 36, N. Y.

. . . deals with central stations other than conventional steam-electric stations; gives fundamentals of water power and of hydro stations, details of equipment used; a third of the book is devoted to the types of oil and gas-burning reciprocating engines and their stations.

WPRA Oil Industry Statistics, covers period from January 1, 1955, to March 31, 1956, 134 pp, Table of Contents, 8½ x 11 in., unbound, published by the Western Petroleum Refiners Association, 1428 Hunt Bldg., Tulsa, Okla.

. . . figures worked up from Bureau of Mines data, with a few exceptions, on supply and demand of petroleum products, crude oil production, refinery runs, etc.

ASTM Standards on Electrical Insulating Materials, by Committee D-9 on Electrical Insulating Materials, 1956, 6 x 9 in., 656 pp., contents listed by material and by specification number, paper cover, $6, but $4.50 to members, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

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Cost Comparison of Fuels

REFINERY FUELS: Fuels used within a refinery cover a wide range, including both natural fuels and byproducts of petroleum processing. Boilers and furnaces may be fired with various grades of heavy fuel oils (both distillates and residuals), natural and refinery gases, and coal and coke in some locations.

Refinery wastes, which have little commercial value, are often burned at the refinery as supplementary fuels and include acid sludge, tars, tank cleanings or "bottoms." A recently tapped source of fuel is the off-gases from the regeneration of catalysts in a catalytic cracking unit. Here the fuel is carbon monoxide.

COMBUSTION FUNDAMENTALS: Combination is a special form of oxidation in which oxygen combines rapidly with certain materials (fuels) and liberates substantial amounts of heat.

The fuels with the most heat value per pound are the most desirable, especially if complete combustion is possible. Fuels containing mostly carbon and hydrogen are the best, as can be seen from the heat values given in the accompanying table. Inert elements in fuels, such as nitrogen, water and inorganic matter, have no heating value, and are undesirable. Sulfur, although it has some heating value, is undesirable because of the corroding product, sulfur dioxide.

Most commercial fuels are hydrocarbons—compounds of carbon and hydrogen only, like methane (CH_4), an important part of natural gas. When a hydrocarbon burns completely the products formed are water (H_2O) and carbon dioxide (CO_2). But to produce this chemical reaction two essentials besides the fuel are required: oxygen and ignition heat.

Characteristics of Combustibles

Material	Formula	Cu ft/lb at 14.7psia, 60°F	Gross Heat Value Btu/lb	Gross Heat Value Btu/cu ft
Acetylene	C_2H_2	14.58	21,502	1483
Butane	C_4H_{10}	6.57	21,316	3370
Carbon	C		14,540	
Carbon monoxide	CO	13.54	4,380	323
Ethane	C_2H_6	12,63	22,300	1762
Ethylene	C_2H_4	13.54	22,200	1641
Gasoline			20,750	
Hydrogen	H_2	188	61,000	325
Methane	CH_4	23.69	24,000	1012
Propane	C_3H_8	8.60	21,360	2580
Sulphur	S		4,050	
Approximate Values:				
Residuals			18,600	
Coal:				
Bituminous			11,500—14,500	
Anthracite			12,000—13,500	
Petroleum Coke			15,200	
Natural Gas:				
Dry				1100
Wet				1300
Oil Gas				550
Lignite			7,200	
Peat			7,000—9,000	

NOTE: Gross heat value — net heat value = the latent heat value of created water vapor at 60°F.

The required oxygen is obtained from the air, which essentially is 20% O_2 and 80% N_2. The inert nitrogen plays no part in combustion but goes along anyway.

Heat of ignition is required because nothing truly burns unless it is in the form of a gas, and most fuels need a starter for chemical combustion with oxygen. Many of the solid fuels require heat for vaporization. When the vapor is formed and combustion begins, then the process is self-sustaining and gives up heat that can be used in boilers and furnaces.

Many fuels, such as natural gas and light fuel oils, will vaporize easily, and this contributes to their easy burning characteristics. But for heavier oils and coal, vaporization is a problem and requires special atomization or pulverization of these fuels for complete burning.

SELECTING THE BEST FUEL: Proper selection of fuel for refinery use depends on:

- heat value
- burning equipment required
- availability
- cost

Probably the most important factor is that of cost—cost per Btu delivered—and its stability.

In general, coal prices tend to be stable while oil and gas prices will vary with local demand and supply. As new uses are found for old fuels in "petrocheming" (remember when hydrogen used to be burned?) the availability of the gas or fuel may suddenly change.

However, one of the first comparisons made in selecting a fuel is the cost/Btu of those available. The table on the back of this page simplifies this comparison for three common fuels.

HOW TO USE COMPARISON TABLE: The table on the back of this sheet compares the cost of oil, gas and coal. It is based on a common denominator—the thousands of Btu's that can be bought for 1 cent.

Two facts are needed for each fuel compared: (1) the unit cost per standard sales unit—$/ton for coal, ¢/gal for oil, and ¢/1,000 cu ft for gas; and (2) the unit heating value—Btu/lb for coal, Btu/gal for oil, and Btu/cu ft for gas. (An alternate method of listing the cost of gas is ¢/therm or per 100,000 Btu).

To compare fuel cost, refer to the table and locate the unit cost for a fuel in the left hand column. Read horizontally to the right to the vertical column headed with the correct Btu value for that fuel. The figure at the intersection is the comparative value for that particular fuel—the thousands of Btu's for one cent. The corresponding cost for either of the other types of fuel can be found in the same way.

EFFICIENCY FACTORS: The values in the fuel comparison table give the gross Btu's available in the fuels. The net usable heat value is obtained by multiplying the figure from the table by burning equipment efficiency. For example: by 80% efficiency in an oil-fired boiler, or 75% efficiency in a gas-fired pipestill, or whatever is the usable efficiency of the combustion equipment employed.

For Comparison Table, Turn the Page . . .

Petroleum Processing's Clip-n-File ENGINEERING DATA SHEET NO. 9

• Thousands of Btu's Supplied for One Penny

OIL

¢/gal	Btu/gal, thousands								
	133	136	138	140	145	149	151	153	156
0.5	266.0	272.0	276.0	280.0	290.0	298.0	302.0	306.0	312.0
1.0	133.0	136.0	138.0	140.0	145.0	149.0	151.0	153.0	156.0
1.5	88.7	91.1	92.0	93.2	97.0	99.2	101.0	102.0	104.0
2.0	66.5	68.0	69.0	70.0	72.5	74.5	75.5	76.5	78.0
2.5	53.2	54.4	55.2	56.0	58.0	59.5	60.4	61.2	62.4
3.0	44.3	45.3	46.0	46.7	48.4	49.6	50.4	51.0	52.0
3.5	38.0	38.8	39.4	40.0	41.5	42.5	43.2	43.7	44.6
4.0	33.2	34.0	34.5	35.0	36.2	37.2	37.7	38.3	39.0
4.5	29.6	30.3	30.6	31.1	32.2	33.1	33.6	34.0	34.6
5.0	26.6	27.2	27.6	28.0	29.0	29.8	30.2	30.6	31.2
5.5	24.2	24.7	25.1	25.4	26.4	27.1	27.4	27.8	28.4
6.0	22.2	22.7	23.0	23.4	24.2	24.8	25.2	25.5	26.0
6.5	20.4	20.9	21.2	21.6	22.3	22.9	23.2	23.6	24.0
7.0	19.0	19.4	19.7	20.0	20.7	21.3	21.6	21.9	22.3
7.5	17.7	18.2	18.4	18.7	19.3	19.8	20.2	20.4	20.8
8.0	16.6	17.0	17.3	17.5	18.2	18.6	18.9	19.2	19.5
8.5	15.7	16.0	16.3	16.5	17.1	17.5	17.8	18.0	18.4
9.0	14.8	15.1	15.3	15.6	16.1	16.6	16.8	17.0	17.3
9.5	14.0	14.3	14.5	14.7	15.3	15.7	15.9	16.1	16.4
10.0	13.3	13.6	13.8	14.0	14.5	14.9	15.1	15.3	15.6
10.5	12.6	13.0	13.2	13.3	13.8	14.2	14.4	14.6	14.9
11.0	12.1	12.4	12.6	12.7	13.2	13.5	13.7	13.9	14.2
11.5	11.5	11.8	12.0	12.2	12.6	13.0	13.1	13.3	13.6
12.0	11.1	11.3	11.5	11.7	12.1	12.4	12.6	12.8	13.0
12.5	10.6	10.9	11.0	11.2	11.6	11.9	12.1	12.2	12.5
13.0	10.2	10.5	10.6	10.7	11.2	11.5	11.6	11.8	12.0
13.5	9.8	10.1	10.2	10.4	10.8	11.0	11.2	11.3	11.6
14.0	9.5	9.7	9.8	10.0	10.4	10.7	10.8	10.9	11.1
14.5	9.2	9.4	9.5	9.6	10.0	10.3	10.4	10.5	10.8
15.0	8.9	9.1	9.2	9.3	9.7	9.9	10.1	10.2	10.4
15.5	8.6	8.8	8.9	9.0	9.4	9.6	9.7	9.9	10.1
16.0	8.3	8.5	8.6	8.7	9.1	9.3	9.4	9.6	9.8
16.5	8.1	8.3	8.4	8.5	8.8	9.0	9.1	9.3	9.5
17.0	7.8	8.0	8.1	8.2	8.5	8.8	8.9	9.0	9.2
17.5	7.6	7.8	7.9	8.0	8.3	8.5	8.6	8.7	8.9
18.0	7.4	7.6	7.7	7.8	8.1	8.3	8.4	8.5	8.7
18.5	7.2	7.4	7.5	7.6	7.8	8.1	8.2	8.3	8.4
19.0	7.0	7.2	7.3	7.4	7.6	7.8	7.9	8.1	8.2
19.5	6.8	7.0	7.1	7.2	7.4	7.6	7.7	7.9	8.0
20.0	6.7	6.8	6.9	7.0	7.2	7.4	7.5	7.7	7.8

COAL

¢/ton	Btu/lb, thousands								
	7	8	9	10	11	12	13	14	15
4.5	31.2	35.4	40.0	44.7	48.8	53.2	57.7	62.1	66.5
5.0	28.0	32.0	36.0	40.0	44.0	48.0	52.0	56.0	60.0
5.5	25.5	29.2	32.7	36.4	40.0	43.6	47.2	50.8	54.5
6.0	23.4	26.6	30.0	33.4	36.6	40.0	43.3	46.6	50.0
6.5	21.6	24.6	27.7	30.7	33.8	36.9	40.0	43.0	46.1
7.0	20.0	22.9	25.7	28.5	31.4	34.3	37.2	40.0	42.8
7.5	18.7	21.4	24.0	26.6	29.4	32.0	34.6	37.4	40.0
8.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5
8.5	16.5	18.8	21.2	22.5	25.9	28.2	30.6	32.9	35.3
9.0	15.6	17.8	20.0	22.2	24.4	26.7	28.9	31.1	33.3
9.5	14.7	16.9	19.0	21.1	23.2	25.2	27.4	28.4	31.6
10.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0
10.5	13.3	15.2	17.2	19.0	21.0	22.8	24.8	26.6	28.6
11.0	12.7	14.5	16.3	18.2	20.0	21.8	23.6	25.4	27.3
11.5	12.2	13.9	15.7	17.4	19.1	20.9	22.6	24.4	26.1
12.0	11.7	13.3	15.0	16.7	18.3	20.0	21.7	23.4	25.0
12.5	11.2	12.8	14.4	16.0	17.6	19.2	21.0	22.4	24.0
13.0	10.8	12.3	13.8	15.4	16.9	18.5	20.0	21.6	23.1
13.5	10.4	11.8	13.3	14.8	16.3	17.8	19.3	20.8	22.2
14.0	10.0	11.4	12.9	14.3	15.7	17.2	18.6	20.0	21.5
14.5	9.6	11.0	12.4	13.8	15.2	16.6	17.9	19.3	20.7
15.0	9.3	10.7	12.0	13.3	14.7	16.0	17.3	18.7	20.0
15.5	9.0	10.3	11.6	12.9	14.2	15.5	16.8	17.9	19.4
16.0	8.7	10.0	10.3	12.5	13.7	15.0	16.2	17.5	18.8
16.5	8.5	9.7	10.9	12.1	13.3	14.6	15.8	17.0	18.2
17.0	8.2	9.4	10.6	11.8	12.9	14.1	15.3	16.5	17.6
17.5	8.0	9.1	10.3	11.4	12.6	13.7	14.9	16.0	17.1
18.0	7.8	8.9	10.0	11.1	12.2	13.3	14.5	15.6	16.7
18.5	7.6	8.7	9.7	10.8	11.9	13.0	14.1	15.1	16.2
19.0	7.4	8.4	9.5	10.5	11.6	12.6	13.7	14.7	15.8
19.5	7.2	8.2	9.2	10.3	11.3	12.3	13.3	14.4	15.4
20.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
20.5	6.8	7.8	8.8	9.7	10.7	11.7	12.7	13.6	14.6
21.0	6.7	7.6	8.6	9.5	10.5	11.4	12.4	13.3	14.3
21.5	6.5	7.4	8.4	9.3	10.2	11.2	12.1	13.0	13.9
22.0	6.4	7.3	8.2	9.1	10.0	10.9	11.8	12.7	13.6
22.5	6.2	7.1	8.0	8.9	9.8	10.7	11.5	12.4	13.3
23.0	6.1	7.0	7.8	8.7	9.5	10.4	11.3	12.2	13.1
23.5	6.0	6.8	7.6	8.5	9.3	10.2	11.1	11.9	12.8
24.0	5.8	6.7	7.5	8.3	9.1	10.0	10.8	11.7	12.5

GAS

¢/1000 ft³	Btu/cu ft							¢/therm	1000's Btu/1 cent
	500	550	600	800	900	1000	1100		
33	15.6	17.2	18.7	25.0	28.2	32.3	34.4	1.0	100.0
34	14.7	16.2	17.7	23.6	26.5	29.4	32.4	1.5	66.7
36	13.9	15.3	16.7	22.2	25.0	27.8	30.6	2.0	50.0
38	13.2	14.5	15.8	21.0	23.7	26.3	29.0	2.5	40.0
40	12.5	13.7	15.0	20.0	22.5	25.0	27.5	3.0	33.3
42	12.0	13.1	14.3	19.0	21.4	23.8	26.2	3.5	28.6
44	11.4	12.5	13.7	18.2	20.4	22.7	25.0	4.0	25.0
46	10.8	12.0	13.0	17.4	19.6	21.8	23.9	4.5	22.2
48	10.4	11.5	12.5	16.7	18.8	20.8	22.9	5.0	20.0
50	10.0	11.0	12.0	16.0	18.0	20.0	22.0	5.5	18.2
52	9.6	10.6	11.5	15.4	17.3	19.2	21.2	6.0	16.7
54	9.3	10.2	11.1	14.8	16.7	18.5	20.4	6.5	15.4
56	8.9	9.8	10.7	14.3	16.1	17.8	19.7	7.0	14.3
58	8.6	9.5	10.3	13.8	15.5	17.3	19.0	7.5	13.3
60	8.3	9.2	10.0	13.3	15.0	16.7	18.3	8.0	12.5
62	8.1	8.9	9.7	12.9	14.5	16.2	17.7	8.5	11.8
64	7.8	8.6	9.4	12.5	14.1	15.7	17.2	9.0	11.1
66	7.6	8.3	9.1	12.1	13.7	15.2	16.7	9.5	10.5
68	7.4	8.1	8.8	11.8	13.2	14.7	16.2	10.0	10.0
70	7.1	7.8	8.6	11.4	12.9	14.3	15.7	10.5	9.5
72	6.9	7.6	8.3	11.1	12.5	13.9	15.3	11.0	9.1
74	6.8	7.4	8.1	10.8	12.2	13.5	14.9	11.5	8.7
76	6.6	7.2	8.0	10.5	11.8	13.2	14.5	12.0	8.3
78	6.4	7.0	7.7	10.3	11.5	12.8	14.1	12.5	8.0
80	6.3	6.9	7.5	10.0	11.3	12.5	13.7	13.0	7.7
82	6.1	6.7	7.3	9.7	11.0	12.2	13.4	13.5	7.4
84	5.9	6.5	7.2	9.5	10.7	11.9	13.1	14.0	7.1
86	5.8	6.4	7.0	9.3	10.5	11.6	12.8	14.5	6.9
88	5.7	6.2	6.8	9.1	10.2	11.4	12.5	15.0	6.7
90	5.6	6.1	6.7	8.9	10.0	11.1	12.2	15.5	6.4
92	5.4	6.0	6.5	8.7	9.8	10.9	12.0	16.0	6.3
94	5.3	5.8	6.4	8.5	9.6	10.6	11.7	16.5	6.1
96	5.2	5.7	6.3	8.3	9.4	10.4	11.5	17.0	5.9
98	5.1	5.6	6.1	8.2	9.2	10.2	11.2	17.5	5.7
100	5.0	5.5	6.0	8.0	9.0	10.0	11.0	18.0	5.6
102	4.9	5.4	5.9	7.8	8.8	9.8	10.8	18.5	5.4
104	4.8	5.3	5.8	7.6	8.6	9.6	10.6	19.0	5.3
106	4.7	5.2	5.7	7.5	8.5	9.4	10.4	19.5	5.1
108	4.6	5.1	5.6	7.4	8.3	9.2	10.2	20.0	5.0
110	4.5	5.0	5.5	7.3	8.2	9.1	10.0	20.5	4.9

(Courtesy, Oil Heat Institute of America, Inc.)

PERSONALS

Mr. Shea

Mr. Turner

Edward L. Shea has been elected chairman of the Ethyl Corp. board. **B. Bynum Turner** has succeeded him as company president. Shea continues to be chief executive officer.

Shea began in the oil industry with Tide Water Oil Co. in 1916. He became its president in 1933. After a period with North American Co. he joined Ethyl as president in 1947.

Turner was with Humble Oil & Refining Co. from 1933 until 1942. After other jobs he began with Ethyl in 1946, and in 1951 was elected vice-president of research and engineering. He was named executive vice-president in 1955.

Charles A. Perlitz, Jr., has been promoted from senior vice-president of Continental Oil Co. to executive vice-president. **Harold G. Osborn,** who was manufacturing vice-president at Ponca City, has become a senior vice-president. **A. W. Tarkington** was also elected senior vice-president. He was vice-president and regional general manager at Ft. Worth.

Lester H. Barnes has been promoted to superintendent of the refinery at Ponca City.

J. W. Vaiden, vice-president of manufacturing for Skelly Oil Co., has been made a senior vice-president.

He has been with Skelly since 1924. In 1934 he was made manager of the natural gasoline and gas department, and in 1941 took the vice-president's post in manufacturing.

Joe D. Walk has been named manager of economics in the manufacturing department of American Oil Co. He was formerly manager of technical service in the manufacturing department of Pan-Am Southern Corp. He will work with Roy J. Diwoky, general manager of manufacturing, in New York.

Robert L. Meuleners has been appointed to the new post of director of technical service in Amoco's research and development department. He will assist Dr. Kasch, manager of research and development, in the New York office. He was previously assistant director of research and development in charge of the technical service division at Texas City.

G. T. Burress has been promoted to group leader, methods development —inorganic group—of the research and development department.

Thomas B. Potter has been named secretary and assistant treasurer of Northwest Nitro-Chemicals Ltd., a Canadian affiliate of Commercial Solvents Corp. He was formerly assistant to the vice-president of the CSC petrochemicals division. He will make his headquarters at Northwest Nitro's plant now under construction at Medicine Hat, Alta.

Bruce K. Brown, president of Pan-Am Southern Corp., will join Petroleum Chemicals, Inc., as president late in 1956.

His new responsibility will begin when Pan-Am merges with American Oil Co. Headquarters of Petroleum Chemicals will be moved from New York to New Orleans. The firm is jointly owned by Continental Oil Co. and Cities Service Co.

H. S. Sparrow has been appointed general manager of the crude and products supply department, a new post in the British American Oil Co. Ltd. He was previously assistant manager of the Montreal East refinery.

Dr. C. W. Smith, assistant department head of Shell Development Co.'s plastics and resins department, has left the Emeryville research center for a two-year assignment as technical assistant to the president of the company in New York. He succeeds **Dr. F. M. McMillan,** who has returned to Emeryville to resume his duties as head of the polymer and chemical applications department.

T. F. Mika, research supervisor in polymer and chemical applications department, has become acting head of Smith's department during the latter's New York assignment.

Thoburn P. Sands and **William B. Hicks** have been appointed section managers in the development department of Monsanto Chemical Co.'s organic chemicals division.

Sands will manage the petroleum chemicals and functional fluids section, and Hicks will have the section assigned to plasticizers, resin materials and paper chemicals.

M. E. Houser has been promoted to superintendent of the Republic Oil Refining Co.

C. H. Barre has been named coordinator of manufacturing. Houser, who was previously chief process engineer, has succeeded **D. B. Smith,** who has resigned to devote himself to his own business, the Refinery Construction Co.

J. M. Evans has been appointed assistant vice-president of the Standard Oil Co. of California. He will give engineering counsel to the operating companies. He was previously chief engineer and his successor is **E. S. Warner,** who has been assistant chief engineer since 1947.

Mr. Thomson

Mr. Hartman

Stuart W. Thomson has been appointed assistant manager of Socony Mobil Oil Co.'s Paulsboro refinery.

R. C. Hartman has been named assistant to the manager.

H. D. Chapman has become operating superintendent, **E. D. Keiper** assistant superintendent of the lube-wax division, and **Elmer L. Smith** assistant superintendent of the light products division.

M. T. Stevens has been appointed manager of the Calgary refinery of British American Oil Co. He has been manager of the Clarkson refinery since 1952.

W. E. Lundy succeeds Stevens at Clarkson. He has been manager of the Moose Jaw refinery for the past seven years.

New manager at Moose Jaw is **B. A. Barnhill,** who comes from the Calgary refinery, where he has been manager since 1953.

C. W. Coote has become manager of the Edmonton refinery, succeeding

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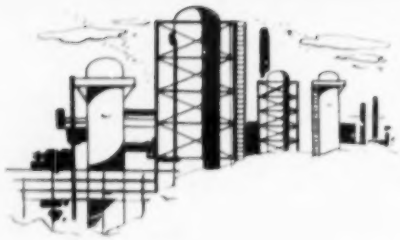

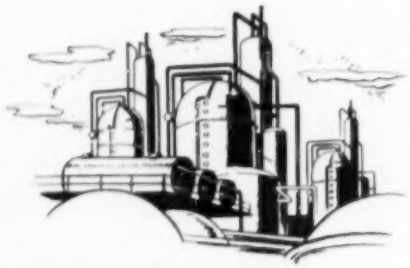

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R. T. Watson, who has retired after 36 years in the company's manufacturing department. Coote moves up from assistant manager of the refinery.

Mr. Ischie

W. Vaughn Ischie has been elected vice-president and general manager of manufacturing for Sinclair Refining Co. He succeeds **T. B. Kimball** recently named director of manufacturing.

Ischie has been assistant to the refineries manager in the New York office since 1953.

Dr. Bernard S. Friedman has been promoted to research associate of Sinclair Research Laboratories. He joined Sinclair in 1948 as an assistant division director.

W. D. Allison and **Clinton W. Bates** have been promoted to supervising engineers, engineering division, at the Baytown refinery of Humble Oil & Refining Co.

Tom F. Stephens and **Irving Leibson** have become senior chemical engineers in the technical service division. **F. M. Orr** has been made technical specialist in the division.

In research and development **J. G. Lillard** has been promoted to senior chemical engineer, **D. E. Nicholson** to senior research chemist, and **Max A. Mosesman** to research specialist.

In the coordination division, **V. B. Brown** and **P. L. Nevil** have advanced to senior coordination technicians.

Harold M. Romig, chief engineer, process engineering division, general engineering department of Standard Oil Co. (Ind.) has retired after 28 years with the industry. He will enter private consulting work in Chicago.

Dr. Fred W. McLafferty has been appointed director of Dow Chemical Co.'s new eastern research laboratory, located at Framingham, Mass. The lab will conduct long-range research in organic and inorganic chemicals and plastics, among other fields.

McLafferty has been working with mass spectrometry and vapor phase chromatography at the company's spectroscopy lab in Midland since 1950.

In the Texas Division, **J. D. Hembree, W. L. May** and **J. D. Whitesides** have been promoted from production

control engineers to senior control engineers.

W. P. Coker has been made laboratory group leader in the organic process development laboratory. **T. W. Mulcihy** and **J. M. Whisenhunt** have been promoted to laboratory supervisor. Coker was laboratory group leader. Mulcihy and Whisenhunt were research and development engineer and chemist, respectively.

Harvey Senturia has been moved from design engineer to engineering group leader in the engineering department.

C. M. Larson has retired from Sinclair Refining Co. as chief consulting engineer and opened private practice as a consultant.

Larson worked for Sinclair as assistant supervising engineer in charge of staff and lubrication engineers; supervising engineer in charge of field and technical services, fuels and lubricants; and in 1937 was made chief consulting engineer.

His consulting address is Larcliff, 55 Taymil Rd., New Rochelle, N. Y.

John T. McCoy has been named manufacturing department coordinator of Tidewater Oil Co. He will represent the new Delaware refinery in the divisional offices in New York. McCoy has been divisional research and development supervisor since 1933.

Charles A. Slikas has been appointed staff assistant at the new refinery. He was formerly a process engineer assigned to the Delaware project.

Hans M. F. Fischer has been made assistant to the vice-president of the Commercial Solvents Corp.'s petrochemicals division.

Fischer was formerly assistant to the general manager of the petrochemicals production department. He succeeds **Thomas Potter,** who has joined Northwest Nitro-Chemicals Ltd.

John C. MacLeod has been appointed assistant director of operations for Solvay Process Division, Allied Chemical & Dye Corp. **Bennett D. Buckles** has become assistant to the vice-president. MacLeod, manager of the Syracuse plant since 1953, has been replaced there by **Clyde A. Kitto.** Kitto moves from the manager's post at Baton Rouge.

George H. Supple, Jr., has been promoted to plant foreman of General

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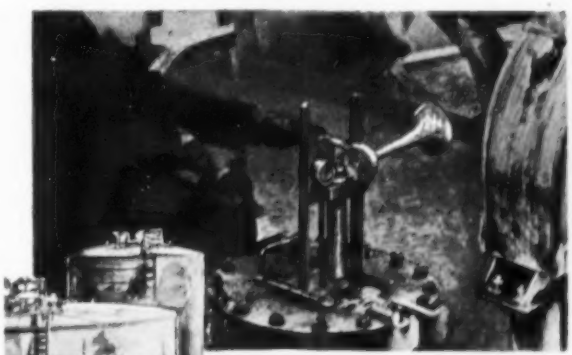
Non-electric, "Dual-Tone Signal Horn, engineered for safety by Falcon, gives distinctive, long-range blast. Self-contained unit, completely portable, is ideal for use in chemical and industrial plants, refineries and other installations.

Freon-powered unit may be manually or remotely operated. Rigid steel guard protects horn and valve assembly.

AUDIO AID AVOIDS TANK OVERFLOW

Automatic signal device for liquid-handling operations



Falcon's Tank Overflow unit automatically signals operator when liquid level approaches capacity level. Loud blast gives ample warning.

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 (To obtain more data on advertised products see page 208)

THIS IS THE STORY of three men and a VALVE. Joe, a chemical engineer, needed valves that could handle tough corrosives. Bill, a refining engineer was looking for valves that gave a positive shut-off. Tom, working for a large industrial firm, needed valves that sealed both upstream and downstream. All three solved their problems by specifying Hamer Visible Wedge Valves. These remarkable valves combine the double sealing action of precision metal-to-metal fit augmented by dependable seal rings.
The wedges are trimmed with nickel, while seats are trimmed with stainless steel to withstand the roughest corrosive conditions.
The full-view wedges are handwheel operated --can't blow out or drop on a toe. The wedges pivot so no lifting is necessary.
So if your plans require long service, sure-seal shut-off valves, by all means specify
HAMER VISIBLE WEDGE VALVES.
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Representatives Throughout the World.

Personals

Petroleum Corp.'s Wilmington, Calif., gas plant. He was formerly a chemical engineer at the Santa Fe Springs laboratory.

Robert W. Sanders, chief chemist, has been promoted to supervisor of chemical operations at the Lockport, Ill., works of The Texas Co. He will be in charge of operations of the ammonia plant now under construction at Lockport.

William H. Roach has been made chief chemist at the Eagle Point works. He returns to the company from the Iranian Oil Refining Co., with which he has been on loan since 1954.

George R. Thompson, general superintendent of the No. 1 refinery in Cleveland of Standard Oil Co. (Ohio),

Mr. Thompson

Mr. McDaniel

has been named general superintendent of the Toledo refinery.

Kenneth A. McDaniel, general superintendent at Toledo, has taken Thompson's post at Cleveland.

Mr. Knepp

George C. Knepp, chief process engineer at the Lima refinery, has been promoted to the new position of project coordinator at Toledo.

Obituary

E. J. Kirberg, coordinator in Gulf Oil Co.'s manufacturing department, died July 19 in Washington, D. C.

He began with Gulf at Port Arthur following his graduation from Pennsylvania State College in 1922. He was transferred to the Pittsburgh general offices in 1936. After several promotions he became manager of the process division in 1950, and last October took the post of coordinator.

Enjay Opens Central Division

Mr. Wadt

Enjay Co., Inc., has formed a new central sales division, with headquarters in Chicago. It will handle all Enjay petrochemicals sales in the central U. S. Willard F. Wadt has been named manager. He was most recently assistant to the president of Enjay, and previously was general superintendent of the Bayonne refinery of Esso Standard Oil Co.

The company already has offices in Chicago and Tulsa. Operations at both offices will be directed by the new division.

Davison Reorganizes Operations

Davison Chemical Co. has reorganized its operating divisions along product lines. Each division is now an autonomous unit with its own functional services, such as engineering, financial, purchasing, etc.

The division heads are general managers who report to W. E. McGuirk, executive vice-president, and Marlin G. Geiger, president. Heading the chemicals, agricultural chemicals, and mixed fertilizer divisions as vice-presidents and general managers are respectively F. C. Nicholson, David N. Hauseman and W. N. Watmough, Jr.

R. D. Goodall, formerly assistant vice-president of marketing, has become general manager of the petroleum catalysts department. A. R. Worrall, who was manager of the Curtis Bay Works, heads industrial chemicals. D. P. Barrett, formerly sales manager of industrial chemicals, is in charge of rare earths.

District sales manager, with headquarters in New York, of the petroleum catalysts department is John Benedict. He has been in the Houston office since 1954, and joined the company in 1950.

Rockwell Plans Nebraska Plant

A valve manufacturing plant is being constructed at Kearney, Neb., by Rockwell Manufacturing Co. To be completed by mid-summer of 1957, the plant will be used for machining, assembly and testing of Rockwell-Nordstrom "Hypreseal" valves.

The 180,000 sq ft facility will employ 500 people ultimately and should cost about $2,000,000. Nearness to midwest and southwest valve markets, good transportation, and availability of labor were the company's reasons for choosing the Kearney site.

SRI Builds "Hot" Lab

A "hot" lab for testing the action of radiation on fuels and lubricants is under construction at the Southwest Research Institute in San Antonio, Texas. The lab is to be part of Pratt and Whitney's nuclear powered aircraft program and will contain two test cells, each capable of handling up to 100,000 curies of cobalt 60.

The facility is expected to cost $600,000 and will be supervised by Al Hundere, chairman of the Institute's department of aviation, engines, fuels and lubricants reasearch.

Ethyl Gives Distler Sales Post

Waldemar J. Distler has become manager of sales administration for Ethyl Corp. He was assistant manager of sales operations formerly, and has been with Ethyl in various sales positions for 21 years.

New district manager of the Dayton office is Norman J. Linstromberg, who was formerly sales representative in Kentucky. He succeeds Robert R. Mead, who is on special assignment at the central region headquarters in Chicago.

Engineers Told to Stay Put

The engineering societies have been advised by their special task committee to remain at their present location in New York City. The societies involved are the American Society of Civil Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, American Institute of Electrical Engineers, American Society of Mechanical Engineers, and the American Institute of Chemical Engineers. All but the last-named now have headquarters in a building stretching between 39th and 40th Sts. in the city.

The committee recommended that the present site be enlarged and rebuilt or that another midtown New York site be found if this proved impractical.

The AIChE plans to join the other four societies if expansion can be carried out. Several other cities had made offers to accommodate the groups.

CEC Building Just Finished

A new research, engineering and marketing building for Consolidated Electrodynamics Corp. has been completed at a cost of $1,500,000. The structure is three stories, has an area of 127,000 sq ft and stands on an 8-acre site in Pasadena, Calif.

Building was designed to provide an environment sympathetic to engineering and creative research, and the areas assigned to these functions have been soundproofed and separated from other activities.

Ryan Next ASME President

Mr. Ryan

William F. Ryan will be the 1956-57 president of the American Society of Mechanical Engineers after the annual meeting in New York next November. Mr. Ryan, who is vice-president, director and senior consulting engineer of Stone & Webster Engineering Corp., was nominated in a ballot of 41,000 ASME members.

He holds two degrees from Harvard College: an A.B. awarded in 1911, and an MME from 1913. He joined Stone & Webster in 1929 and served as assistant chief mechanical engineer, assistant engineering manager, and engineering manager before being named a vice-president in 1950.

CB&I Builds New Plate Plant

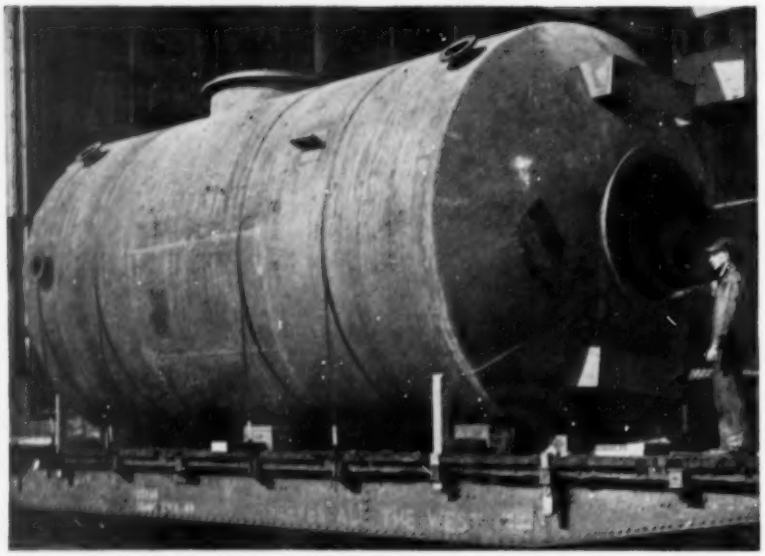
A steel plate fabricating plant will be built at New Castle, Del., by Chicago Bridge & Iron Co. to supplement the production of field-erected storage tanks and similar structures by the Greenville, Pa., plant.

There will be a single fabricating building and an outside crane runway for handling and storing materials. The building is expected to be completed in about a year.

SD Appoints Dr. Marlowe

Dr. George J. Marlowe has been appointed director of project evaluation for Scientific Design Co. He has been with American Cyanamid Co. for the past six years and was supervising process engineer in the organic chemicals division.

He received his B.E. degree from



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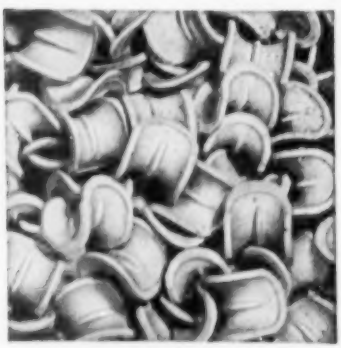
Knight engineers design and build towers for processing high temperature gases. They are specialists in steel masonry constructions for high temperatures as well as corrosive service. Following installations are typical:

Mannheim furnace gas cooler	1100°F
Waste HCl gas disposal	2100°F
Removal of fly ash from flue gas	600°F
Kiln gas cooler	1600°F
Condenser for submerged combustion gases	240°F
Herreshoff roaster gas scrubber	700°F
Sulfur burner gas scrubber	950°F
Smelter gas cleaner and cooler	800°F

In these towers, Knight engineers used steel shells lined with PYROFLEX sheet membrane that resists thermal decomposition. Over this membrane goes insulating and acid brick bonded in Knight's High Temperature Cement. Knight Towers give superior performance because:



Berl Saddles Tower Packing More Area, Higher Capacity, Less Resistance

No moving parts, simple to operate.
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When your processing includes cooling, absorption, condensation, or scrubbing; send us the facts on service conditions for specific recommendations.

Maurice A. Knight 957 Kelly Ave., Akron 6, Ohio
Acid and Alkali-proof Chemical Equipment

Yale University in 1947 and an Sc.D. degree in chemical engineering from M.I.T. in 1950.

Dr. Farkas Joins Houdry Labs

Dr. Farkas

Dr. Adalbert Farkas has joined the research and development division of Houdry Process Corp. as section chief in exploratory research at the Linwood, Pa., laboratories. He will direct research on new chemicals and chemical processes.

Dr. Farkas was formerly with the Barrett Division of Allied Chemical & Dye Corp. He supervised chemical research groups engaged in production and utilization of organic intermediates taken from coal tar and petroleum chemicals.

He holds Ph.D. degrees in physical and industrial chemistry from Frankfurt University and the Technical University of Vienna. He was a research fellow at European universities after graduation and later did research on oxygenated derivatives of petroleum hydrocarbons and diesel fuel improvement for Union Oil Co.

Schutt Now Consultant to Trade

Hermann C. Schutt, formerly a consultant to Badger Process Division of Stone & Webster Engineering Corp., now offers his services directly to firms in the petroleum and chemical industries. His areas of interest are production of acetylene, ethylene and other hydrocarbons; synthesis of organic chemicals; project planning and management; and process and apparatus design.

Mr. Schutt's offices are at 201 Devonshire St., Boston 10, Mass. Phone is Hancock 6-3450.

Personnel Changes

Badger Mfg. Co.—A. W. Ackerman to the New York sales staff. He will work with engineering, procurement, and construction of petroleum, petrochemical and chemical facilities. He was formerly in the New York contract sales department of the Lummus Co.

Rockwell Mfg. Co.—Russell L. Sylvester to chief engineer of the central

valve research and development department. He was formerly with New York Air Brake Co.

Selas Corp. of America—Harry V. Wenger, Jr., to Pacific-northwest sales representative.

Davison Chemical Co.—John B. Thompson to field service engineer at Baltimore, succeeding Albert J. Gnesin, who has transferred to San Francisco.

Calumet & Hecla Inc.—B. J. Wuerthner to the sales staff of the mid-west district of Wolverine Tube Division.

Monsanto Chemical Co.—George R. Buchanan, Jr., to associate manager of petroleum chemicals sales for the organic chemicals division. He was manager of resin materials and functional fluids in the division's development department.

Fischer & Porter Co.—Robert F. Lane, assistant to the president, to the board of directors; Marvin D. Weiss to manager of the analytical division of the research department. He was formerly chief of the chemical instruments division of Taller and Cooper.

Consolidated Electrodynamics Corp.—Philias H. Girouard to assistant director of engineering. He was formerly chief engineer of the U. S. Navy Bureau of Ordnance.

Minneapolis-Honeywell Regulator Co.—Glenn E. Seidel to new post of vice-president of engineering, coordinating and directing research and engineering throughout the company; K. Russell Knoblauch to sales manager for the oil and chemical industries for the eastern region of the industrial division.

Branches, Distributors

Hills-McCanna Co. has appointed General Meters and Controls Co., 205 Wacker Dr., Chicago, as sales representatives in northern Illinois for chemical metering and proportioning pumps and force feed lubricators; Telco, Inc., 4030 Superior Ave., Cleveland, will handle the company's diaphragm valves in northern Ohio.

Conoflow Corp., has appointed Chemical & Industrial Sales, Ltd., of

Colored Insulation for Industry
with foster Lagtone
PROTECTION & COLOR-CODING COMBINED IN ONE RUGGED COATING FOR THERMAL INSULATION ON PIPES, DUCTS, VESSELS . . .
Now! A single protective coating for indoor and outdoor thermal insulations . . . combines the decorative advantages of seven attractive colors (plus black and white) with outstanding protection from weather, chemical fumes, and physical abuse.
Lagtone can be used over all insulating materials, and on heated or refrigerated piping, ducts, and equipment. Non-toxic . . . nonflammable . . . effective over wide extremes of ambient temperature.
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PETROLEUM PROCESSING—Subscription Department
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Edmonton, sales-engineering representative in Alberta and Saskatchewan, Canada.

Davison Chemical Co. has opened an office in San Francisco at 2 Pine St., with Albert J. Gnesin, in charge as field service engineer representing both industrial chemicals and petroleum catalysts departments.

Fischer & Porter Co. has opened a sales office in Pensacola, Fla., at 603 Rue Max St. Office covers territory along the Gulf Coast, parts of Florida, Alabama and Mississippi formerly handled out of New Orleans.

Industrial Models, Inc., has opened a branch office in Pittsburgh, with Paul Steiner as area supervisor.

Expansion, Transition

Eastman Chemical Products, Inc., has set up a chemical sales development section separate from commercial sales department. New section will work with Kingsport laboratory to develop new products to commercial stage and to fit special products to specific end-use requirements of customers. Manager is William M. Gearhart, formerly chief chemist of labs.

Consolidated Electrodynamics Corp. has acquired Electronic Industries, Inc., Burbank, which specializes in etched circuitry development and production. It will retain its present name and activity.

American Industrial Models, Ltd., is the new subsidiary at Mancnester, England, of Industrial Models, Inc., of Wilmington, Del. M. K. Brown of New York is manager; J. R. Rowland, Jr., of Wilmington is manager director of European operations. The first European branch of the firm was opened at The Hague two years ago.

C. W. Nofsinger Co. will collaborate with Long Construction Co., also in Kansas City, on intergrated projects for the petroleum and chemical industries—i.e., overall design and construction. For ordinary work they will continue to operate separately.

Stauffer Chemical Co. will, with stockholder approval, acquire West End Chemical Co., maker of borax, soda ash, salt cake and lime. Company will operate as autonomous division of Stauffer.

Since "way back when," Monsanto has been helping lube manufacturers like you with the chemical problems of petroleum additives.

Modern Example:

IMPROVING GEAR LUBE PERFORMANCE TO MEET THE EXACTING MILITARY AND AUTOMOTIVE SPECIFICATIONS FOR HIGH-TORQUE, HIGH-SPEED OPERATION

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Superior High-Torque Performance . . . for the past year Santopoid 22 has protected expensive heavy-duty worm-gear trucks used in grueling mountain hauling.

Excellent High-Speed Protection . . . before adding Santopoid 22, a racing car chewed up rear-end gears every 75-100 miles. Since changing to a Santopoid 22 fortified gear lube, 350 miles plus 100 warm-up miles have been clocked with gears still OK.

When you write specifications for your product, before investing in expensive tests . . . call in Monsanto. Monsanto can formulate your base stock—ready for field testing—with dozens of possible additives that will do just about any job an additive can do. Corrosion inhibitors • Detergents • Viscosity index improvers • Gear lubricant fortifiers Fuel oil clarifiers • "Oiliness" improvers.

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Organic Chemicals Division

Department OA-2

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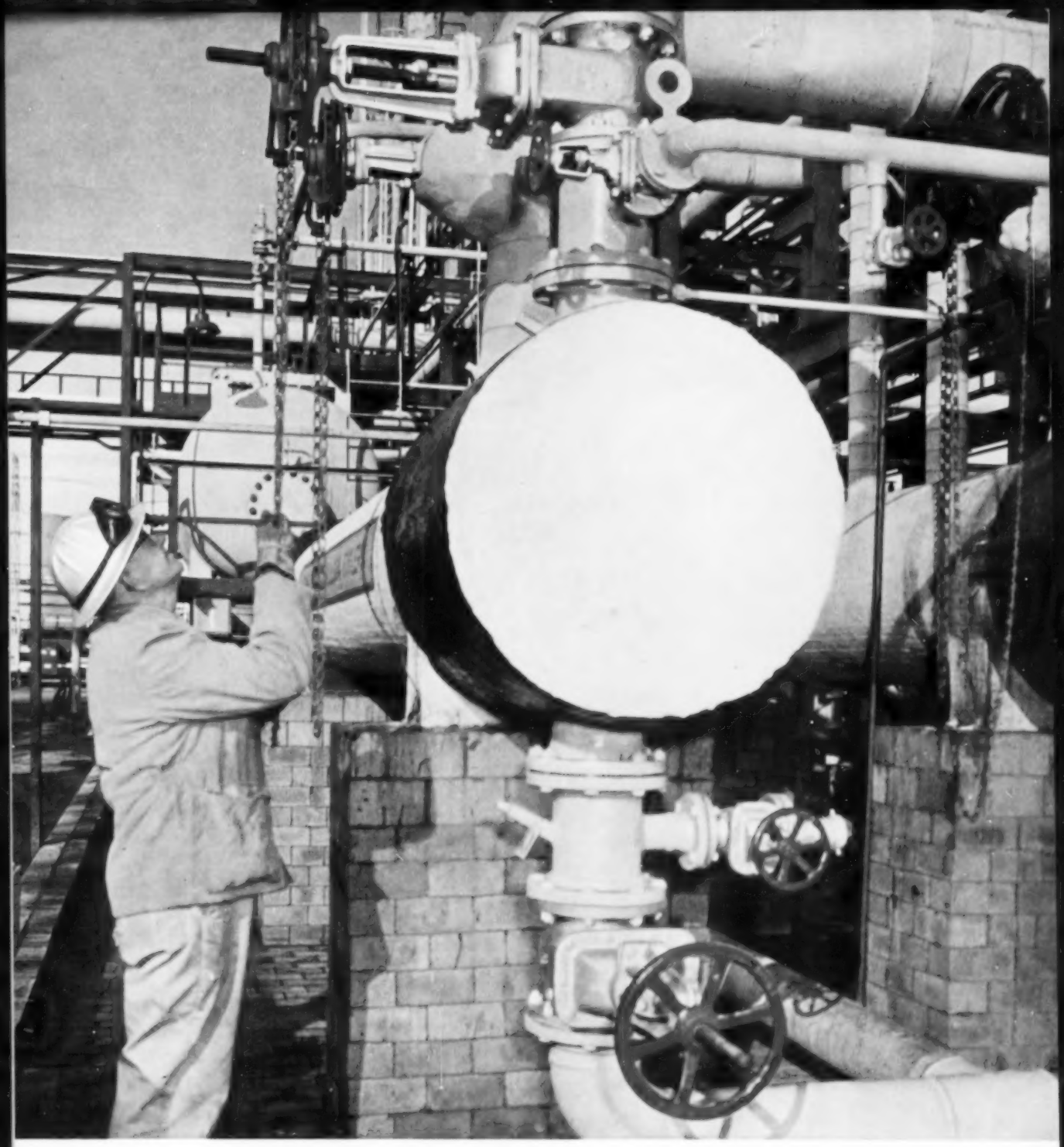

Closing the gate on hard-to-hold hydrocarbons

At Esso Standard Oil's Bayway Refinery light hydrocarbons are used extensively at a wide range of temperatures and pressures.

Light hydrocarbons are hard to "hold," but the self-adjusting wedge design on Aloyco gate valves insures tight shut-off. Corrosion-resistant Aloyco valves — like the red-wheeled, chain-operated gate valve above — are used throughout many process units.

You'll see many more of them on key jobs at leading petroleum, processing and chemical plants throughout the country. What about your corrosives-handling problems? Write Alloy Steel Products Company, Inc., 1301 West Elizabeth Avenue, Linden, New Jersey.

42

Longer Lasting
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VALVES
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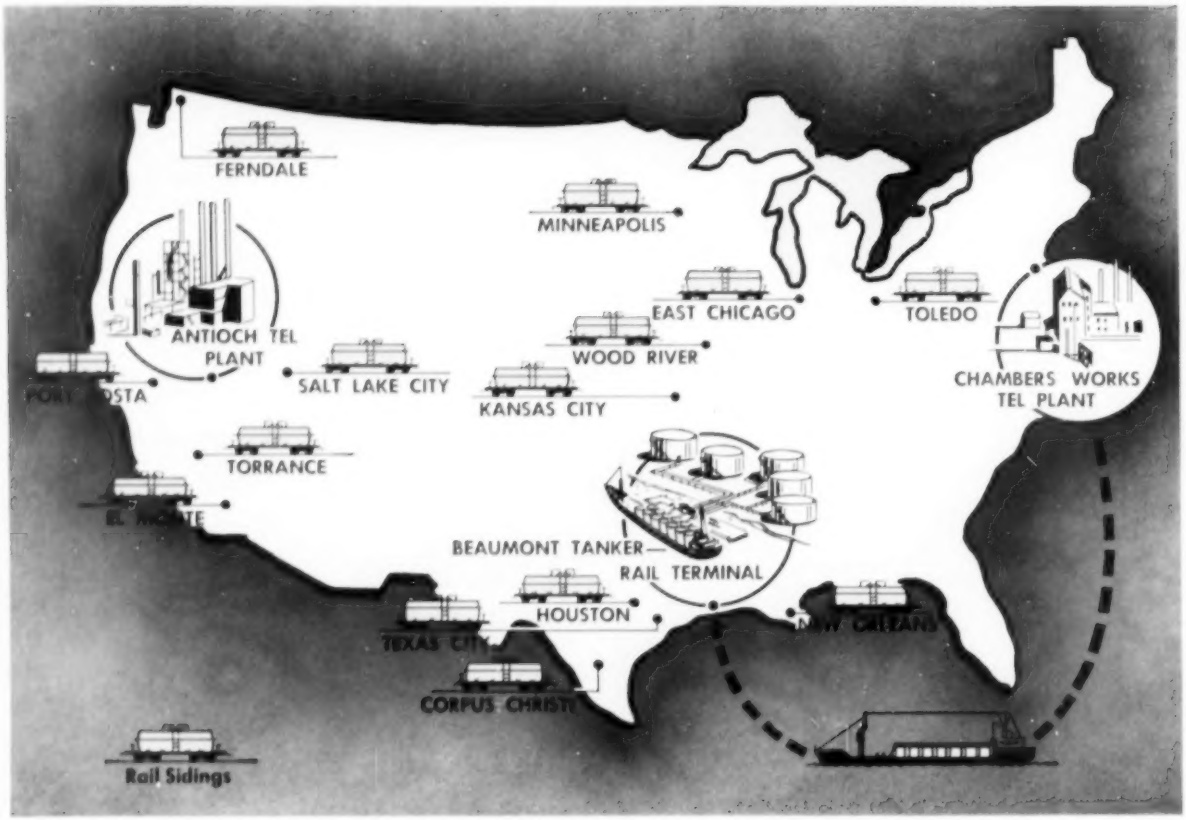
Subsidiary of Walworth Company



Du Pont's expanded production and delivery program moves ahead

West Coast TEL plant to go on stream by year's end . . . special tanker will transport TEL by sea for first time . . . new Du Pont storage and delivery terminal nears completion at Beaumont, Texas.

The Du Pont Petroleum Chemicals 1956 expansion program is nearing completion. It will meet increasing requirements, insuring ample TEL supplies and fast delivery service to refiners in all parts of the country.

On the West Coast

Du Pont's new TEL plant at Antioch, California, the most modern in the world, is now well over 50% complete. It is expected to go on stream by the end of 1956. Readily accessible to water, truck, and rail transportation, this means larger supplies and faster deliveries for West Coast refineries.

Gulf Coast

A tanker-supplied storage and delivery terminal is nearing completion at Beaumont, Texas. TEL will be transported from Du Pont's Chambers Works at Carney's Point, N. J., to Beaumont in a specially built tanker. This will be the first time TEL has ever been shipped in bulk by sea.

Upon inauguration of this service, Gulf Coast and mid-continent refineries will have additional assurance of ample TEL supplies.

Nationally

Refiners all over the country can benefit by Du Pont's increased TEL supply facilities including the many existing storage points throughout the nation.

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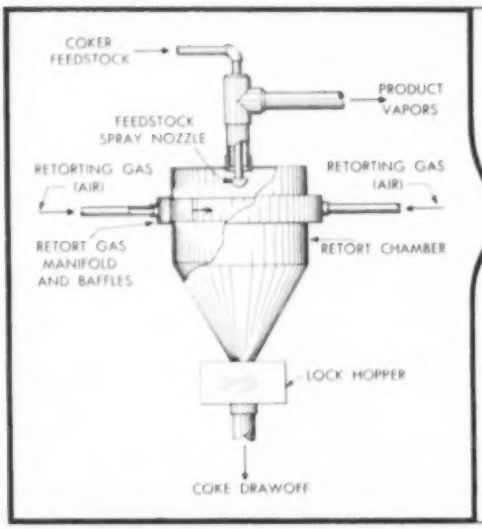

Fig. 1—**RETORT VESSEL** for continuous flash coking of petroleum feedstocks

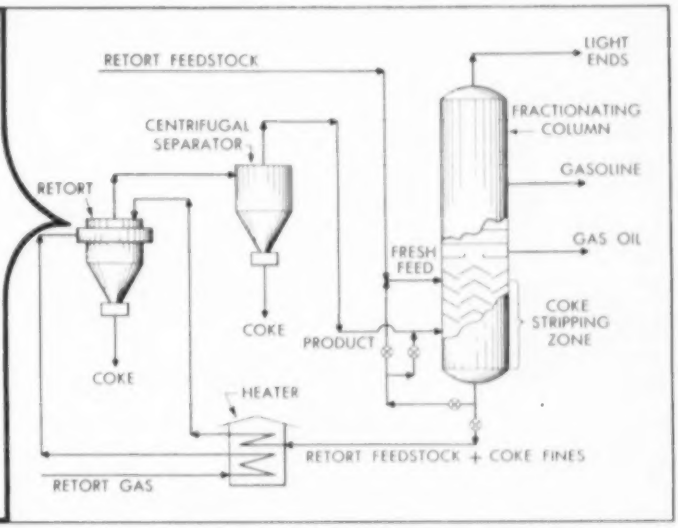

Fig. 2—**COKE RECYCLE** scheme removes coke fines from coking retort effluent

New Flash Coking Process Gives . . .

Low Coke, High Aromatics from Residuums

CONVENTIONAL COKING of petroleum residuums has been standard procedure for many years as a means of getting valuable liquid materials from otherwise low-value residuum.

Coke formed during these coking operations is usually 1.8-2.5 times the value indicated by the Conradson carbon test, with coking stocks normally having Conradson values of 12-20. A reduction in the amount of coke formed would be a real contribution, because much of the coke is formed at the expense of more valuable liquid hydrocarbon products.

A new process of residuum coking (or retorting), recently patented by California Research Corp. (U.S. Pat. 2,751,334), is claimed to form little, if any, coke over and above the Conradson carbon values.

The secret of the process is not to give the liquid feedstock time to be degraded by thermal cracking. In this way, coke is reduced to a minimum, the naphtha product is highly aromatic with an aniline point below 0°F (compared to over 100°F for other coking processes), the gas oil fraction is said to be a better catalytic cracking stock, and the tail gas stream is high in olefins, rather than saturated paraffins.

The Continuous Retorter

Liquid feedstock is sprayed continuously into the retorting vessel through the central spray nozzle (shown in Fig. 1). Hot retorting gases (usually air) enter an annular space on the vessel side, and are directed by baffles into a tangentially spinning motion around the periphery of the retort reaction zone.

Feedstock spray is rapidly picked up in the vortex of the spinning gases, and carried outward by the centrifugal force of the spinning gases. As the spray particles travel toward the vessel periphery, they are rapidly coked to dryness by the hot gases.

Volatilized products stripped from the coke are then withdrawn axially from the reactor at the top center, taking with them a fair quantity of coke fines. This withdrawal is rapid, thus reducing the chances of further thermal cracking of the vapor. Heavier coke particles fall to the bottom of the retort vessel and are removed through the lock hopper.

Flash Coking Results

Table 1 illustrates flash coking results for three different feedstocks. In all of these examples, a portion of the feedstock is burned to help preheat the retorting air, and thus the reaction zone.

Aromatic and unsaturated hydrocarbon formation during the flash coking is illustrated for catalytic cycle oil (last column of Table 1) by the analysis given in Table 2. It will be noted that only 0.23% of the feed was converted to coke during this reaction.

Most of the coke is in the form of hollow globules, cenospheres, or fragments of them. These particles have

Something New . . .

. . . has been added to your patents department, starting with this issue. It is a complete revamp of the patents listing, aimed at making the department more helpful to you.

Turn to p. 163 for details.

Table 1—Typical Results from Continuous Flash Coking Process

Liquid Feedstock	—Boscan Residuum—		Santa Maria Residuum	Catalytic Cycle Oil
Gravity, °API	8.9		9	24.3
Sulfur, wt%	5.5		5.34	—
Visc., SSU @ 130°F	30,000		36,000	48.9
Pour point, °F	—		—	65
Aniline point, °F	—		—	64
Conradson carbon, wt%	9.9		11	0.18
ASTM Boiling range, °F	—		—	568/760
Operating Conditions				
Feed rate, lb/hr	2,800	2,800	56.5	107
Feed preheat, °F	900	—	300	—
Feed burned,(1) wt%	3.2	2.35	15.5	8.5
Air rate, lb/hr	1,142	952	91.5	107
Air inlet temp., °F	945	865	room	850
Steam rate, lb/hr	none	392	none	22.5
Periphery temp., °F	2,100	—	2,000	1200-1400
Residence time, secs.	2-4	—	—	—
Reactor volume, cu ft.	—	—	3	3
Product gas temp., °F	1,100	—	1,025	1,070
Pressure, psig	50	—	—	—
Products, wt%				
C_4 and lighter	7.5	2.9	—	98.2(4)
C_5, total	2.5	1.7	—	1.3(4)
C_6, total	2.2	0.7	—	0.5(4)
Total C_4 and lighter	12.2	5.3	25(5)	—
C_5, total	1.5	0.55	—	—
Total C_5 and lighter	13.7	5.85	—	—
Gasoline	11.1(2)	11.1(2)	11.5(5,6)	see Table 2
Gas oil	59.0(3)	67.7(3)	88.7(5,7)	—
Coke	13.0	13.2	14.0	0.23

(1) Weight per cent of feed burned to heat reactor.
(2) Gasoline fraction: C_5/400°F, 37° API, blended aniline point of —40°F.
(3) Gas oil fraction: 400°F+, 16° API.
(4) Based on total gaseous products only.
(5) Based on total liquid products only.
(6) Gasoline fraction: 200/357°F, 26.3° API, blended aniline point of —48°F.
(7) Gas oil fraction: 357°F+, 1.4° API, 117 SSU @ 130°F.

Table 2—Composition of Gasoline — Continuous Flash Coking of Cycle Oil

(see last column of Table 1 for more details)

Product Gasoline Properties	
End point, °F	410
Blended aniline point, °F	—77
Gravity, °API	31.7
Bromine number	62
Product Gasoline Composition	
Aromatic hydrocarbons, %	79
Aliphatic olefins, %	14
Paraffins and naphthenes, %	7

normal diameters of 20-200 microns, with the particle's wall diameter usually less than one-tenth the particle diameter. Bulk density is usually 2-3 lb/cu ft, normally within the range of 2.3-2.7.

It's necessary to remove the coke particles from the retort's effluent gases, but mechanical or gravity separation methods are not satisfactory. The solution to coke removal is to recycle the fines, so that they grow progressively larger (coking the liquid layer on the coke particle) until they leave the retort by gravity.

Fig. 2 illustrates a process system utilizing the flash coker and coke fines recycle.

Retort effluent passes through a centrifugal separator, then enters the stripping column below the point where fresh feedstock enters. The descending fresh feedstock washes the coke fines out of the reactor effluent, with fines and fresh feedstock (plus some uncoked heavy material) leaving the bottom of the stripper.

Stripper bottoms are then preheated before being sent to the retort. Lighter retorter product vapors (gases, gasoline and gas oil) leave the top of the stripper.

Because the coke recycled to the retort vessel has a thin layer of fresh feedstock, the coking action deposits additional coke on the particle, making it heavy enough to drop to the bottom of the retort, from where it can be removed from the system.

An example of this process system for Boscan residuum, shows that the reactor feedstock contains about 1% coke after operating equilibrium is reached. Total C_4 and lighter products for this method of operation on Boscan residuum are 16%, the gasoline fraction 10.8% and the gas oil fraction 57%.

Here's More of Your New Patent Briefs

PROCESSES AND METHODS (starts on p. 163)

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
gellation	hydrocarbon liquids	aluminum alkoxide and fatty acid	Standard Oil Co. (Ind.)	2,751,284
hydration	olefins	tungsten oxide cat. & high press.	Imperial Chemical Industries Ltd.	2,751,420
hydrogenation	carbon monoxide	Fe cat. containing Cu and Ag	Ruhrchemie AG	2,753,367
	coal-in-oil suspension	associated catalyst and steam	Texaco Development Corp.	2,753,296
isomerization	bicyclo—(2.2.1)-2,5-heptadiene	in heated chamber at atmos. pressure	Shell Development Co.	2,754,337
manufacture	acetylene	heating & cracking of hydrocarbon gas	Koppers Co., Inc.	2,751,424
	aldehydes	carbonylation of olefin-diolefin mix.	Imperial Chemical Industries, Ltd.	2,752,395-7
	copolymer drying oil	butadiene, styrene & Na catalyst	Esso Research & Engrg. Co.	2,753,385
	ethylene from ethane	autothermic cracking process	Esso Research & Engr. Co.	2,752,407
	finely divided alumina	combustion of aluminum alcoholate	Esso Research & Engrg. Co.	2,754,176
	fuels from gases	Fischer-Tropsch process & Co cat.	Chemische Werke Essener Steinkohle AG	2,751,404
	gelling agent	Al-salt, alkali octanoate & hvy. oil	Standard Oil Co. (Ind.)	2,751,360

(Continued on p. 195)

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
manufacture	high viscosity lubes	reblend with condensed-ring aromatics	Esso Research & Engrg. Co.	2,754,254
	hydrazine	actinic light & vapor phase NH_3-H_2	M. W. Kellogg Co.	2,753,300
	isobutyl alcohol	catalytic CO hydrogenation	Badische Anilin & Soda Fabrik AG	2,753,366
	MO-containing catalysts	aqueous oxalic acid soln.	Universal Oil Products Co.	2,753,310
	mono-n-alkylbenzenes	HH and BF_3 catalyst	Standard Oil Co. (Ind.)	2,753,383-4
	organic compounds	CO and H_2 using Fe catalyst	M. W. Kellogg Co.	2,751,405
	plasticizers	esterification & carbonylation of cracked paraffin wax	Shell Development Co.	2,754,321
	porous plastic solids	slurry filtration and polymerization	Sun Oil Co.	2,754,274-5
	silica hydrosols	aqueous alkali metal silicate reaction	Esso Research & Engrg. Co.	2,754,270
	fertilizer	Ca PO_4, H_2SO_4 & sulfonated aromatic oil	Esso Research & Engrg. Co.	2,754,190
	synthesis gas	hydrocarbon & molten alk. metal carbonate	Houdry Process Corp.	2,754,187
	synthesis gas	partial oxidation reaction	Hydrocarbon Research, Inc.	2,752,232
	thia-amines	formaldehyde, thiol & ammonium salt	Standard Oil Co. (Ind.)	2,754,328
measurement	hipropellant ignition delay	photo cell in combustion chamber	Phillips Petroleum Co.	2,753,934
operation	rich oil strip. still	flashing, steam & sp. gravity meas.	Phillips Petroleum Co.	2,754,246
oxidation	aromatic methyl & methylene gps.	formation of carbonyl groups	Socony Mobil Oil Co., Inc.	2,753,377
	ethylene	silver—containing catalyst	Chempatents, Inc.	2,752,361
	olefins	fluid, silver—containing catalyst	Vulcan Copper & Supply Co.	2,752,363
	olefinically unsats.	H_2O and cat. with Cr, Mo, or W & S, Se or Te	Shell Development Co.	2,754,325
oxo synthesis	alcohols	Al, Fe or Mg in reactor induction zone	Esso Research & Engrg. Co.	2,754,332
polymerization	aromatic hydrocarbons	initial thermal reaction with H_2	Esso Research & Engrg. Co.	2,754,340
	1, 3-butadiene cmpds.	aqueous emulsion reaction	Sun Oil Co.	2,752,330
	cracked naphtha stream	boron fluoride catalyst	Esso Research & Engrg. Co.	2,753,326
	ethylene-higher alkanol wax	di-tertiary-butyl peroxide catalyst	Esso Research & Engrg. Co.	2,754,278
	ethylenically unsats.	droplets through sq. catalyst soln.	Shell Development Co.	2,754,289
	petroleum resins	unsaturated, steam-cracked streams	Esso Research & Engrg. Co.	2,754,288
	steam cracked C's	Al-halide catalyst	Esso Research & Engrg. Co.	2,753,325
prevention	plume	cool cat. zone in moving—bed reactor	Socony Mobil Oil Co., Inc.	2,753,295
propulsion	Reaction motors	ozidizer & triethyltrithiophosphite	Standard Oil Co. (Ind.)	2,753,683
purification	crystals	heated cylinder using piston	Phillips Petroleum Co.	2,752,230
reaction	propane & isoparaffin	$AlCl_3$ in liq. phase reaction	Sun Oil Co.	2,751,423
recovery	Co-carbonylation cat.	conversion & extraction from aldehydes	Esso Research & Engrg. Co.	2,751,403
	cyclodienes	cracking & dist. from cracked petroleum	Esso Research & Engrg. Co.	2,751,422
reduction	engine octane demand	BF_3 reaction product additive	Standard Oil Co. (Ohio)	2,751,285
refining	lubricating oil	moving clay-bed contactor	Lummus Co.	2,751,336
reforming	hydrocarbons	fluid reactor and transfer line regen.	Esso Research & Engrg. Co.	2,752,291
	naphthas	fluid system using contin. cat. regen.	Esso Research & Engr. Co.	2,751,332
regeneration	silica-magnesia cracking catalyst	oxygen combustion with added steam	Sinclair Refining Co.	2,754,272
removal	olefins from benzene	H_2SO_4, caustic and distillation	Esso Research & Engrg. Co.	2,753,387
retorting	shale	moving bed, using hot gas	California Research Corp.	2,752,292
separation	acetone & methanol	dist. & extraction from aq. mixtures	Stanolind Oil & Gas Co.	2,751,337
	acetylenic gas cmpds.	solvent process	Pure Oil Co.	2,753,012
	aromatics	extraction of light cracked gasoline	Phillips Petroleum Co.	2,754,342
	conjugated diolefins	selective polymerization	The Texas Co.	2,751,331
	diolefins from petrol.	codimerization and distillation	Esso Research & Engrg. Co.	2,752,406
separation	gaseous mixtures	low-temperature system	M. W. Kellogg Co.	2,753,701
	iron sulfide from clay	acid leaching and washing	Houdry Process Corp.	2,754,273
stabilization	oils above gasoline	drying and aqueous alkaline treat	Socony Mobil Co., Inc.	2,754,253
storage	liquid propane	vaporization cooling	Chicago Bridge & Iron Co.	2,753,691
sulfurization	mineral or fatty oils	S or phosphorous sulfides and Na_2PO_4	Esso Research & Engrg. Co.	2,753,332
suspension	heat exchanger plates	suspension rod and locks	Aktiebolaget Separator	2,754,093
sweetening	thermal naphthas	two-stages, oxidation and extraction	Standard Oil Co. (Ind.)	2,754,251
treating	fluids	multiple chambered vessel	Adsorption Research Co.	2,751,032 & 034
	fluids	vessel using internal distributors	Jefferson Lake Sulfur Co.	2,751,033
	oil-water emulsions	heated tank	National Tank Co.	2,751,998

(Continued on p. 196)

PRODUCTS

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
asphalt	chlorosulfonated polyethylene	regular asphalt	Standard Oil Co. (Ind.)	2,752,316
deactivation	metal "deteriorants"	2-(2-hydroxyphenyl) imidazole additives	Universal Oil Products Co.	2,754,216
detergents	aqueous mixture	Na-salts and sec-alkyl sulfates	Shell Development Co.	2,751,358
fluid suspension	carbon black	copolymer coating in mineral oil	Shell Development Co.	2,754,267
gelling agent	basic Al alkanoate	two alkanoate radicals	Standard Oil Co. (Ind.)	2,751,359 & 361
	Al-octanoate soaps	heat treatment	Standard Oil Co. (Ind.)	2,751,283
grease	synthetic lube	Li-soap of hydrogenated fish oil acid	Esso Research & Engrg. Co.	2,751,351
	lubricating oil	carboxylic acid metal salt complex	Esso Research & Engrg. Co.	2,754,268
	lubricating oil	polyamide-polyamate thickener	California Research Corp.	2,752,312
	lubricating oil	silica gel and aliphatic diol	Sun Oil Co.	2,752,310
	oleaginous liquid	inorganic gelling agent	Pure Oil Co.	2,751,349
hydraulic fluid	ethylene glycol & water	soap, nitrite, triethanolamine, etc.	Studebaker-Packard Corp.	2,751,355
	synth. lube polymer	solvent and soap	Genesee Research Corp.	2,751,356
lubricant	hydrocarbon lube stock	oxidized bright stock	California Research Corp.	2,753,307
	lubricating oil	naphthenic white oil oxidation acids	Esso Research & Engrg. Co.	2,754,269
	lubricating oil	Mg and Zn organic cmpds.	The Texas Co.	2,752,311
lubricant	lubricating oil	organo-metallic derivatives	Standard Oil Co. (Ind.)	2,753,306
magnetic fluid	liq. hydrocarbon mix.	iron particles	Shell Development Co.	2,751,352
oil (rust-inhibited)	silicate oil & sulfonate	alkyl polyalkylene glycol ether	California Research Corp.	2,751,350
pipe thread compound	alk. petrol. sulfonate	mineral oil, powdered solids & water	Union Oil Co. of Calif.	2,754,266
reforming catalyst	plat. & act. alumina	isomerization & dehydrogenation ability	Houdry Process Corp.	2,751,333
stabilizer	ethylene urea	sat. aliph. polycarboxylic acid salts	Monsanto Chemical Co.	2,751,394

EQUIPMENT

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
analysis	fluid cat. carbon	combustion apparatus	Standard Oil Co. (Ind.)	2,753,246
	gas streams	catalytic reaction chamber	Baker & Co., Inc.	2,751,281
burning	CO in flue gases	muffle-tube chamber	Sinclair Refining Co.	2,753,925
cleaning	pipe exteriors	rotating abrasive surface	P. E. Petit	2,751,728
contacting	gas and liquid	contact tray	Koch Engrg. Co., Inc.	2,752,139
	ion-exchange resins	liquids in expansible resin bed	Socony Mobil Oil Co., Inc.	2,754,262
	liquids	cut-away plates in tower	Esso Research & Engrg. Co.	2,754,096
control	fluid pressure	valve using movable piston	Ferranti Ltd.	2,750,952
coupling	pipes	flexible or rigid connection	Victaulic Co. of America	2,752,173-4
detection	water in oil	electroconductive cell	Ohio Ferro-Alloys Corp.	2,752,586
distribution	liquids in evaporators	bell having vertical tubes	Blaw-Knox Co.	2,753,932
fractionation	fluids	bubble-cap with L-shaped members	Universal Oil Products Co.	2,753,166
	liquid mixtures	sonic wave in column	L. L. Friend, Jr.	2,754,257
gasification	carbonaceous fuels	chamber using moving bed	Koppers Co., Inc.	2,751,287
	finely-divided fuel	ceramic lined chamber	Koppers Co., Inc.	2,751,286
heating	fluids	chamber using moving pebbles	Phillips Petroleum Co.	2,751,211-2
	fluids	radiant heater	Shell Development Co.	2,751,893
	fluids in tubes	combustion gases	L. A. Mekler	2,752,897
manufacture	acetylene	partitioned chamber using conduits	Union Oil Co. of Calif	2,751,282
measurement	hydrocarbon flash pts.	constant temperature apparatus	Standard Oil Co., (Ind.)	2,752,776-7
	liquid level	acoustic waves	Bogue Electric Mfg. Co.	2,753,542
	liquid level	capacitance change indicator	Liquidometer Corp.	2,751,531
	liquid level	capacitance unit & bridge network	Minneapolis-Honeywell Reg. Co.	2,754,457
	liquid level	float gage	L. Exley	2,752,784
	liquid level	float, rod and torsion tube	Phillips Petroleum Co.	2,753,885
	liquid level	remote reading gage	Societe Anonyme Etablissments	2,752,783
	liquid level	signal device	OPW Corp.	2,751,877
	liquid level	vertical float chamber	Minneapolis-Honeywell Reg. Co.	2,751,178
	pipe temperature	thermocouple band	Thermo Electric Co.	2,752,411
polymerization	reactive fluids	tubular reactor with flow restrictions	Esso Research & Engrg. Co.	2,753,249
pumping	fluids	variable displacement, flex. diaphragm	Standard Oil Co. (Ind.)	2,752,852
separation	metals from liquid	rotating cylinder and magnet	Phillips Petroleum Co.	2,754,000
shipment	liquids	drum using flexible diaphragm	E. I. du Pont de Nemours & Co.	2,751,073
storage	fluids	pressure tank	Superior Tank & Constr. Co.	2,751,755
testing	gases and vapors	apparatus with catalytic filament	Standard Oil Co. (Ind.)	2,753,247
timing	intervals	rotating, marked drums	Phillips Petroleum Co.	2,754,169
thermal diffuson	liquids	ports and slits	Standard Oil Co. (Ohio)	2,752,042
valve diaphragm	elastic material	trough shape	Soundrive Pump Co.	2,750,959
welding	seams	horizontal plate	M. W. Kellogg Co.	2,752,468

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AAM								X					
AO						X	X						
AR		X								X			
BGM		X											
BN						X	X						X
BUL				X	X			X			X		X
CC			X							X			
CE			X							X			
CX											X		
MS			X							X	X	X	X
0.19	X				X	X	X		X				X
0.20	X				X	X	X		X				X
TO									X				

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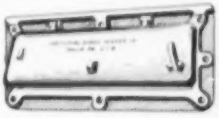

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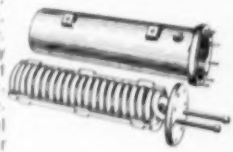

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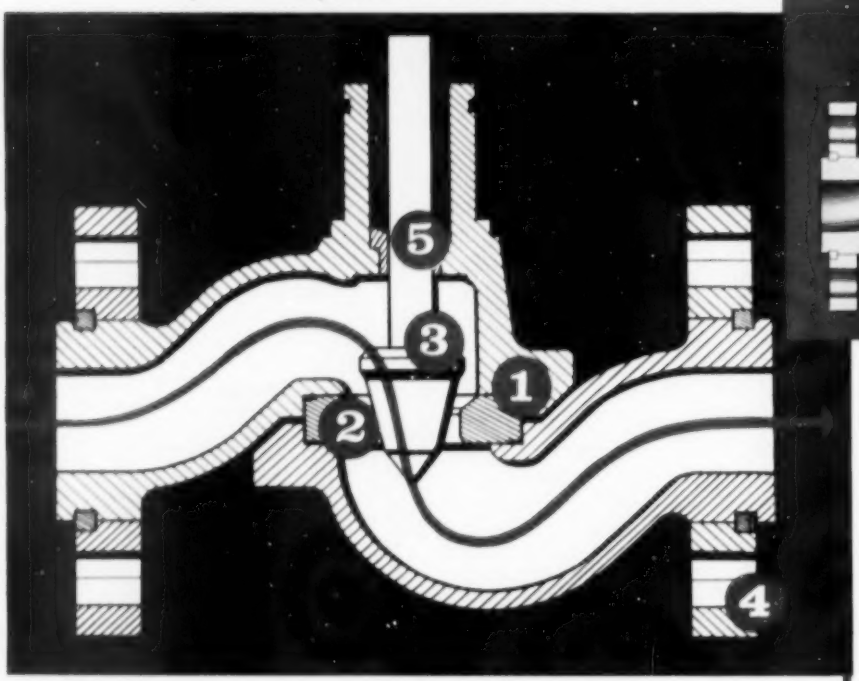

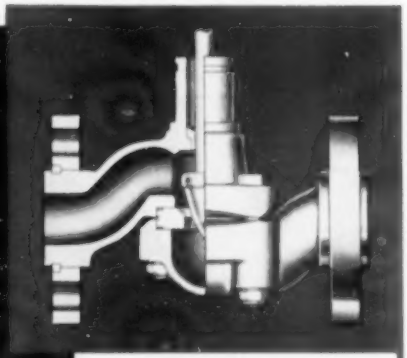

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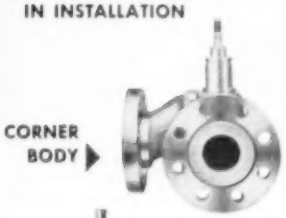

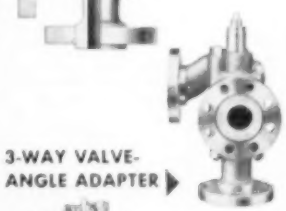

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Refiners' Topics at ASTM Meeting

TURBINE OILS, lubricating oils, radiation in experiments, and other topics of interest to oil men will be presented at the Los Angeles meeting of the American Society for Testing Materials, Sept. 17-21. Hotel Statler is the site of the event—the second Pacific area national meeting of the Society—and an exhibit of various testing apparatus will also be featured.

A selection of papers to be heard in the symposia on turbine and lubricating oils is as follows:

"Recommended Practice for the Design of Turbine Systems," by C. F. Kottcamp, Gulf Oil Co.

"Fire-Resistant Turbine Fluids," by L. W. Manley and G. H. S. Snyder, Socony Mobil Oil Co.

"Anti-Wear Requirements for Navy Turbine Oils," by H. E. King, Bureau of Ships, and J. R. Belt, USN Engineering Experiment Station.

"Evaluation and Performance of Turbine Oils," by G. H. von Fuchs, consultant.

"Practices for Determining the Expected Life of Used Turbine Oils," by R. G. Mastin, Cities Service Oil Co.

"Rusting in Turbine Oiling Systems," by N. W. Furby, F. J. Hanly, California Research Corp., and J. A. Vincent, Standard Oil Co. of California.

"Monolayers of Anti-Rust Additives," by H. E. Ries, H. D. Cook, and C. M. Loane, Standard Oil Co. (Ind.)

"Water Leaching of Additives," by E. W. Brennan and R. G. Moyer, Pure Oil Co.

"Direct Reading Spectrographic Control of Lubricating Oil Additive Manufacture," by R. E. Ramsey, California Research Corp., and W. A. Rappold, Oronite Chemical Co.

"Application of X-Ray Spectrography to Refinery Control of Additive Lubricating Oils," by E. N. Davis, Sinclair Research Laboratories.

"Direct Determination of Metals in Used Engine Oils by Emission Spectroscopy," by W. D. Perkins, Shell Oil Co.

There is to be a symposium on vapor phase oxidation of gasoline, and these papers will be heard:

"Fuel Factors Affecting Intake System Deposits," by C. R. Bauer and H. J. Scheule, Du Pont Co.

"Features of a Bench Test for Induction System Gum," by J. L. Keller and F. S. Liggett, Union Oil Co. of California.

"Effect of Fuel Composition Upon Intake Valve Deposit-Forming Characteristics," by A. V. Cabal, Socony Mobil Oil Co.

"Induction System Reactions—Liquid or Vapor?," by A. C. Nixon, H. B. Minor and I. P. Rudy, Shell Development Co.

"Occurence and Significance of Vapor Phase Oxidation in Army Engine," N. L. Klein, Army Ordnance Department.

The Los Angeles meeting will feature symposia on radiation of materials and on radioactive isotopes. Among the papers to be heard are:

"Radiation and Hot-Cell Facilities," by G. D. Calkins et al, Battelle Memorial Institute.

"Mechanics of Testing Irradiated Materials," by R. Berggren, C. Dismuke, M. J. Feldman, J. C. Wilson, Oak Ridge National Laboratory.

"The Westinghouse Test Reactor," by M. A. Schultz, Westinghouse Electric Corp.

"Survey of Radiation Effects on Fuel Materials," by D. Bowen, Atomics International, North American Aviation, Inc.

"Refinery-Scale Applications of Radioactive Tracers," by V. P. Gumm, H. R. Lukens, Jr., and D. C. Wagner, Shell Development Co.

There will be a Petroleum Industry Luncheon on Monday, Sept. 17. Committee D-2, on Petroleum Products and Lubricants, will hold its fall meeting in Los Angeles and has scheduled sessions throughout the week.

Lube Additives a Topic at ACS Meeting, Sept. 16-21

Symposia on additives in lubricants, hydrogen in the petroleum industry, polycyclic hydrocarbons, and other topics will be heard at the annual meeting of the American Chemical Society, Sept. 16-21, in Atlantic City.

Here are titles of some of the symposia and the sponsoring division.

Catalytic Salts (Chemical Marketing and Economics)

Industrial Gases (Gas and Fuel Chemistry)

Chemical Processes (Industrial and Engineering Chemistry)

Air Pollution (same)

Aromatic Substitution (Organic Chemistry)

Polycyclic Hydrocarbons (Organic Chemistry, jointly with Petroleum Chemistry Division)

Use of Hydrogen in the Petroleum Industry (Petroleum Chemistry)

(Continued on next page)

Oil Man's Calendar

(Bold-face items reviewed this issue)

SEPTEMBER

9-12 American Institute of Chemical Engineers, Penn Hotel, Pittsburgh

10-12 American Society of Mechanical Engineers, fall meeting, Cosmopolitan Hotel, Denver

10-14 International Congress on Catalysis, Bellevue-Stratford, Philadelphia

11-13 Pacific Coast Gas Assn., Coronado, Calif.

12-14 National Petroleum Assn., annual, Traymore Hotel, Atlantic City

13-15 Chemical Institute of Canada, western regional conference, Edmonton

16-21 American Chemical Society, annual, Atlantic City

17-19 Electrical Conference of the Petroleum Industry, American Institute of Electrical Engineers, Kansas City, Mo.

17-21 American Society for Testing Materials, Pacific area national meeting, Statler Hotel, Los Angeles. Includes fall meeting, Committee D-2, Petroleum Products and Lubricants

17-21 Instrument Society of America, Instrument-Automation Conference and Exhibit, Coliseum, New York

20-21 Western Petroleum Refiners Assn., regional technical-industrial relations meeting, Hotel Henning, Casper, Wyo.

24-26 Petroleum Mechanical Engineering Conference, American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas

24-25 Independent Oil Compounders Assn., annual, Bismarck, Chicago

28 Natural Gasoline Assn. of America, regional, Skirvin Hotel, Oklahoma City, Okla.

OCTOBER

1-5 American Institute of Electrical Engineers, fall general meeting, Morrison Hotel, Chicago

8-10 Lubrication Conference, sponsored by ASLE and ASME, Chalfonte-Haddon Hall, Atlantic City

11-12 California Natural Gasoline Assn., fall meeting, Sheraton Huntington Hotel, Pasadena

14-20 Oil Progress Week

15-17 National Assn. of Corrosion Engineers, northeast region, Philadelphia

16-17 American Gas Assn., annual, Atlantic City

18-19 Western Petroleum Refiners Assn., regional technical-industrial relations meeting, Rufus Garrett Hotel, El Dorado, Ark.

22-24 Rocky Mountain Oil & Gas Assn., annual, Cosmopolitan Hotel, Denver

22-24 National Lubricating Grease Institute, annual, Edgewater Beach Hotel, Chicago

23-26 National Assn. of Corrosion Engineers, south central region, San Antonio, Texas

25-26 National Society of Professional Engineers, fall meeting, Greenbrier, White Sulphur Springs, W. Va.

26 Natural Gasoline Assn. of America, regional, Capt. Shreve and Washington Youree Hotels, Shreveport

NOVEMBER

1-2 Society of Automotive Engineers, diesel engine meeting, Drake Hotel, Chicago

8-9 Society of Automotive Engineers, fuels and lubricants meeting, Mayo Hotel, Tulsa

8-9 National Assn. of Corrosion Engineers, southeast region, Charlotte, N. C.

12-15 American Petroleum Institute, annual, Conrad Hilton and Palmer House, Chicago

15-16 National Assn. of Corrosion Engineers, north central region, Detroit

26-30 3rd International Automation Exposition, Coliseum, New York

30 Natural Gasoline Assn. of America, Permian Basin regional meeting, Herring Hotel, Amarillo, Texas

Additives in Lubricants (same)
New Olefin Polymers (Polymer Chemistry)
Analytical Methods for Water and Waste Water (Water, Sewage and Sanitation (Chemistry)

IOCA to Offer Paper on Transmission Fluids

Independent Oil Compounders Association will hold its annual meeting at the Bismarck Hotel, Chicago, Sept. 24-25. Among the meeting's highlights will be a paper discussing "The Present Status of Automatic Transmission Fluid, Type A," by Norman A. Hunstad, assistant head, fuels and lubricants department research staff, General Motors Corp.

A visit to the research and development laboratores of Pure Oil Co. has been arranged for Sept. 26.

Lewis to Talk at Texas U. On Fluidization Advances

Recent advances in fluidization will be the topic of Prof. Warren Kendall Lewis, of Massachusetts Institute of Technology, when he opens the Shoch lecture series at the University of Texas, Oct. 16 and 17. The three lectures Prof. Lewis will present inaugurate a series in honor of Dr. E. P. Schoch, U. of Texas professor emeritus. Lectures are open to the public.

Refining to Be a Topic at NACE Regional, Oct. 23-26

Corrosion in oil refining will share the spotlight with other topics at the Oct. 23-26 meeting of the South Central Region, National Association of Corrosion Engineers, at San Antonio. This meeting was originally scheduled for Beaumont.

High temperature corrosion problems to be discussed in four papers include oxidation of iron-nickel alloys, hydrogen sulfide's effect on various metals, catalytic refining equipment corrosion, and zirconium corrosion in water over 200°C.

An exhibition of corrosion control materials and equipment will be displayed for the first time at a NACE regional meeting.

NLGI Annual, Oct. 22-24, At Chicago's 'Edgewater'

The National Lubricating Greases Institute will hold its 24th annual meeting, Oct. 22-24, at the Edgewater Beach Hotel in Chicago.

Among the activities will be a 2½-hour forum on the lubrication of ball bearings, which will have Dr. H. L. Leland, Esso Research & Engineering Co., as chairman.

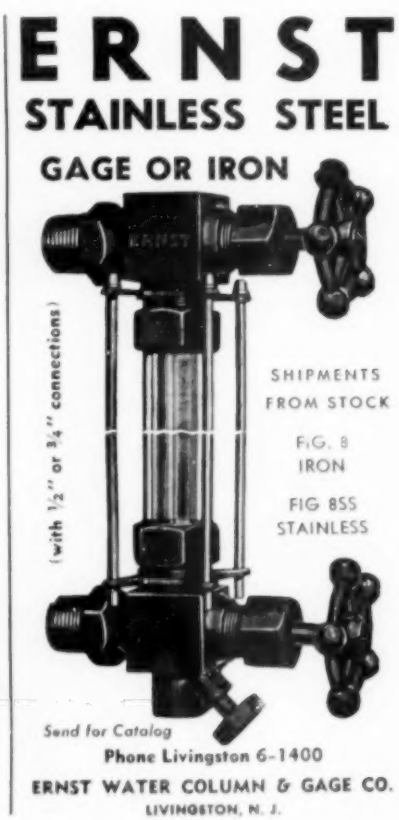
Some papers to be heard are:

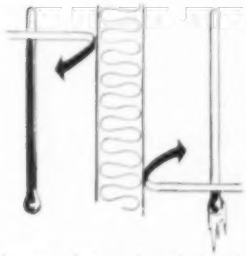
"Manufacture of Lithium Soap Greases and Calcium Greases by Electric Heating," by D. F. Rhodes, Canadian Oil Co.

"Metal Carbonates Coated with Salts of Low Molecular Weight Polycarboxylic Acids as Grease Thickeners," by E. W. Nelson, W. W. Woods, C. R. Bergen, W. P. Scott and R. M. Tillman, all of Continental Oil Co.

"Molybdenum Disulfide as a Grease Additive," by E. E. Smith, Climax Molybdenum Co.

"A New Synthetic Thickener for Multipurpose Lubricating Greases," by J. L. Dreher, B. W. Hotten, C. F. Carter, California Research Corp.





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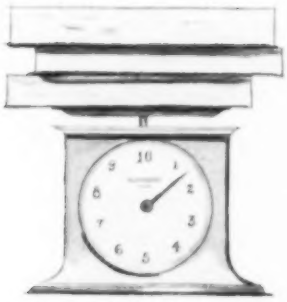

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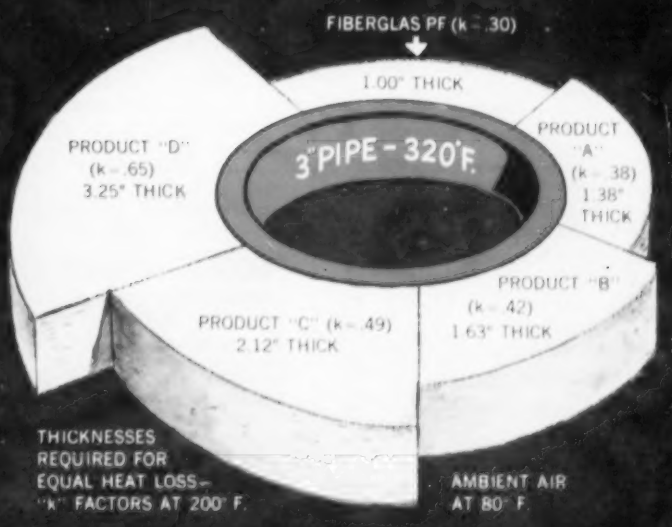
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AMBIENT AIR AT 80° F.

for insulating efficiency!

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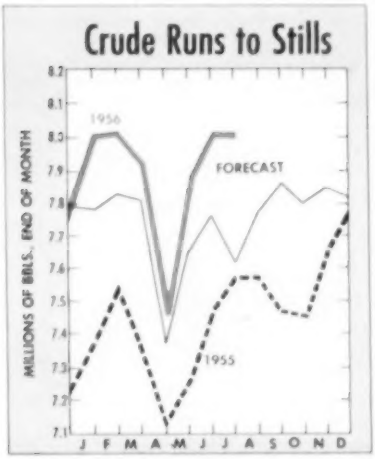
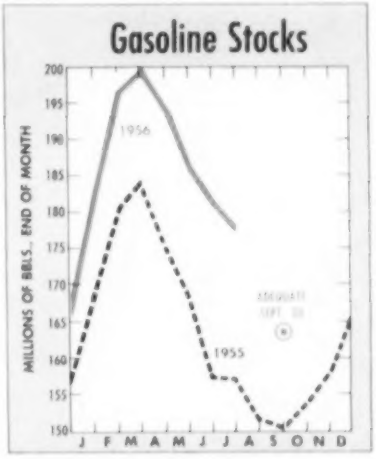
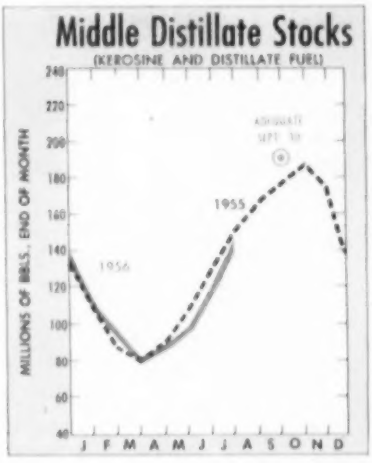






Gasoline Stocks Stay High

GASOLINE demand continues about 5% higher than 1955, but output at refineries is just high enough so that withdrawals from storage are not in the volume required to bring these inventories into balance with supply-demand needs by fall and winter, under normal conditions. Unless runs to stills are sharply curtailed, gasoline inventories may not dip much below 170,000,000 bbl at their low point this fall, while some refiners believe that 160,000,000 bbl would be adequate.

Continued tension in the Middle East and uncertainty over the future of the Suez Canal could change the status of gasoline stocks from a burdensome level to a cushion against emergency requirements on U. S. refiners from European markets. Currently this is only a psychological factor.

OUTLOOK: For refiners' major product stocks to top 400,000,000 bbl before Oct. 1.

Total U. S. gasoline stocks Aug. 3 were 177,561,000 bbl (API data), 13.5% larger than Aug. 5, 1955. Withdrawals from storage since March 31 have been around 22,000,000 bbl, while they were about 27,000,000 bbl last year. Indicated withdrawals in July were considerably larger than in July, 1955.

Refiners' stocks of distillate fuel oil Aug. 3 were at the 1955 level. Their buildup lagged during the late spring because of the abnormally high demand for heating oils. The increase in recent weeks is at a rate that, if continued, will push their total Sept. 30 to well above the 146,500,000 bbl that are now believed adequate for that date.

Crude runs in July were 8,011,000 b/d avg., about 5.7% higher than in July, 1955. The Bureau of Mines forecasts crude runs in August at 7,980,000 b/d avg., about 5.3% higher than last August. Gasoline yield in August is expected to be 43.5% of crude charged. The high rate of refinery operations is pushing total stocks for the major refined products toward an all-time peak of 400,000,000 bbl.

JULY KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbl. at end of month)

	July 1956	June 1956	July 1955
CRUDE OIL			
U. S. Production	7.089	7.040	6.632
Imports	1.067	.937	.832
U. S. Stocks	277.895	274.677	264.601
Runs to Stills	8.011	8.051	7.580
GASOLINE			
Refinery Output	3.893	3.903	3.744
Refinery Demand	4.119	4.126	3.847
Primary Stocks	177.344	181.032	157.079
MIDDLE DISTILLATES			
Refinery Output	2.114	2.045	1.861
Refinery Demand	1.279	1.315	1.185
Primary Stocks	146.147	120.251	151.918
RESIDUALS			
Refinery Output	1.108	1.119	1.091
Imports & Other	.352	.415	.253
Total Supply	1.458	1.534	1.344
Refinery Demand	1.283	1.438	1.328
Primary Stocks	43.938	38.575	44.894

PRODUCTS AND CRUDE PRICES

(Products—¢ gal, weighted average prices in principal refinery markets
Crudes—$/bbl, principal fields
Source—Platt's Oilgram Price Service)

	July 1956	June 1956	July 1955
Gasoline (regular)	12.13	12.05	11.38
Distillate Fuel Oil	9.33	9.34	8.88
Kerosine	10.92	10.95	10.45
Residuals	5.26	5.20	4.59
Above 4 Products	9.59	9.53	8.92
Lube Oils	22.69	22.63	16.86
Crude	2.84	2.84	2.82

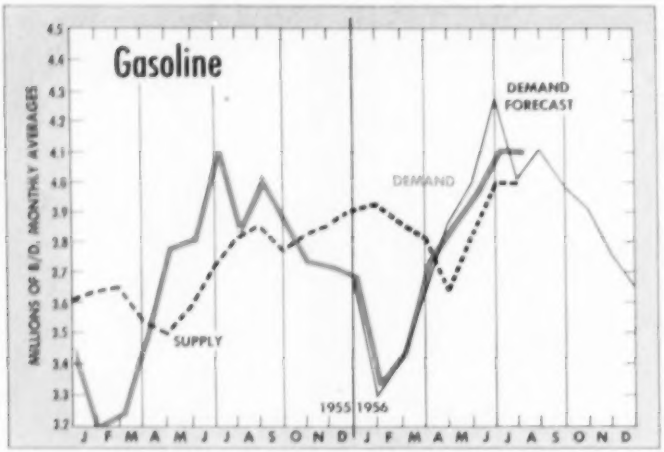
REFINERY YIELDS

% on Crude Runs to Stills

	July 1956	June 1956	July 1955
Gasoline	44.3	44.3	44.9
Kerosine	3.8	3.7	3.8
Distillate	22.6	21.7	20.8
Residuals	13.8	13.9	14.4

SOURCE OF DATA (except prices): June and July, API weekly reports; earlier months, Bureau of Mines

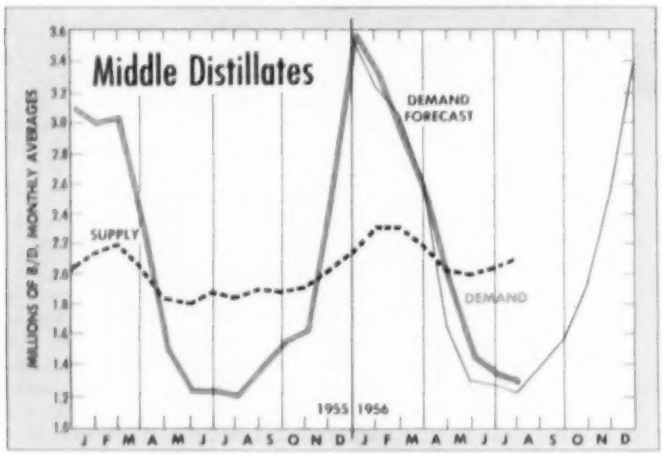
Gasoline Shipments Are 4,120,000 b/d Avg.



MOTOR FUEL

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
July '56	3.550	.450	4.000
July '55	3.406	.418	3.824
Change	+ .144	+ .032	+ .176
% Change	+ 4.2	+ 7.6	+ 4.6
DEMAND (including Exports) (Millions of b/d)			
July '56			4.120
July '55			3.847
Change			+ .273
% Change			+ 7.0
TOTAL SUPPLY (Millions of bbl)			
7 Mos. '56	732.703	92.638	825.341
7 Mos. '55	683.732	88.391	772.123
Change	+ 48.971	+ 4.247	+ 53.218
% Change	+ 7.2	+ 4.8	+ 6.9
TOTAL DEMAND (including Exports) (Millions of bbl)			
6 Mos. '56			813.171
6 Mos. '55			772,930
Change			+ 40.241
% Change			+ 5.2

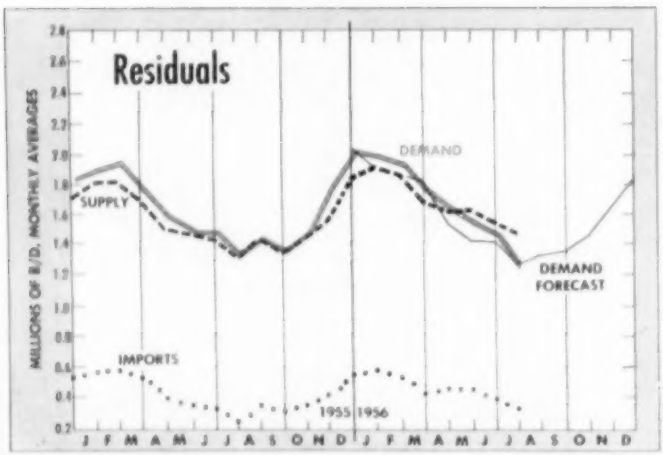
Distillate Demand Nears Seasonal Low


Middle Distillates
DEMAND FORECAST
SUPPLY
DEMAND
1955 1956
MILLIONS OF B/D. MONTHLY AVERAGES
J F M A M J J A S O N D J F M A M J J A S O N D

MIDDLE DISTILLATES

	Kerosine	Dist. Fuel Oil	Total
PRODUCTION (Millions of b/d)			
July '56	.301	1.813	2.114
July '55	.286	1.575	1.961
Change	+ .015	+ .238	+ .253
% Change	+ 5.2	+ 15.1	+ 13.6
DEMAND (including Exports) (Millions of b/d)			
July '56	.192	1.087	1.279
July '55	.192	.993	1.185
Change	—	+ .094	+ .094
% Change	—	+ 9.5	+ 7.9
TOTAL PRODUCTION (Millions of bbl.)			
7 Mos. '56	69.882	383.069	452.951
7 Mos. '55	69.714	349.222	418.936
Change	+ .168	+ 33.847	+ 34.015
% Change	+ 0.2	+ 9.7	+ 8.1
TOTAL DEMAND (including Exports) (Millions of bbl.)			
7 Mos. '56	68.096	381.440	449.536
7 Mos. '55	64.791	341.230	406.021
Change	+ 3.305	+ 40.210	+ 43.515
% Change	+ 5.1	+ 11.8	+ 10.7

Residual Fuel Oils Coast at 1955 Level


Residuals
DEMAND
SUPPLY
DEMAND FORECAST
IMPORTS
1955 1956
MILLIONS OF B/D. MONTHLY AVERAGES
J F M A M J J A S O N D J F M A M J J A S O N D

RESIDUAL FUELS

	Refinery Output	Imports & Others	Total
SUPPLY (Millions of b/d)			
July '56	1.106	.352	1.458
July '56	1.091	.253	1.344
Change	+ .015	+ .099	+ .114
% Change	+ 1.3	+ 39.1	+ 8.5
DEMAND (including Exports) (Millions of b/d)			
July '56			1.283
July '55			1.328
Change			— .045
% Change			— 3.4
TOTAL SUPPLY (Millions of bbl)			
7 Mos. '56	253.907	100.985	354.892
7 Mos. '55	243.610	93.557	337.167
Change	+ 10.297	+ 7.428	+ 17.725
% Change	+ 4.2	+ 7.9	+ 5.3
TOTAL DEMAND (including Exports) (Millions of bbl)			
7 Mos. '56			349.187
7 Mos. '55			344.378
Change			+ 4.809
% Change			+ 1.4

SOURCE OF DATA: June and July, API weekly reports; earlier months, Bureau of Mines (1956 figures for 366 days)

RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U. S. REFINERY DISTRICTS

(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

RUNS TO STILLS
(Millions of b/d average for week ending on date shown)

District	July 27 1956	July 29 1955	Change	% Change
East Coast	1.162	1.130	+ .032	+ 2.8
Gulf Coast	2.643	2.384	+ .259	+ 10.9
Total Coastal	3.805	3.514	+ .291	+ 8.3
Appalachian	.196	.207	— .011	— 5.3
Ind.-Ill.-Ky.	1.449	1.445	+ .004	+ 0.3
Okla.-Kans.-Mo.	.767	.676	+ .091	+ 13.5
Other Inland	.688	.636	+ .052	+ 8.2
Total Inland	3.100	2.964	+ .136	+ 4.6
Total East of Calif.	6.905	6.478	+ .427	+ 6.6
California	1.085	1.099	— .014	— 1.3
Total U. S.	7.990	7.577	+ .413	+ 5.5

GASOLINE STOCKS
(Millions of bbl on date shown)

July 27 1956	July 29 1955	Change	% Change
40.396	35.151	+ 5.245	+ 14.9
34.670	30.334	+ 4.336	+ 14.3
75.066	65.485	+ 9.581	+ 14.6
7.571	6.589	+ .982	+ 14.9
35.366	34.176	+ 1.190	+ 3.5
18.476	14.679	+ 3.797	+ 25.9
18.225	16.347	+ 1.878	+ 11.5
79.638	71.791	+ 7.847	+ 10.9
154.704	137.276	+ 17.428	+ 12.7
22.348	19.729	+ 2.619	+ 13.3
177.052	157.005	+ 20.047	+ 12.8

RESIDUAL STOCKS
(Millions of bbl on date shown)

July 27 1956	July 29 1955	Change	% Change
11.216	10.436	+ .780	+ 7.5
8.322	6.973	+ 1.349	+ 19.4
19.538	17.409	+ 2.129	+ 12.2
.938	.716	+ .222	+ 31.0
5.052	5.135	— .083	— 1.6
1.473	1.105	+ .368	+ 33.3
2.608	2.178	+ .431	+ 19.8
10.072	9.134	+ .938	+ 10.3
29.610	28.543	+ 3.067	+ 11.6
13.558	18.914	— 5.356	— 28.3
43.168	45.457	— 2.289	— 5.0

DISTILLATE FUEL OIL STOCKS
(Millions of bbl on date shown)

District	July 27 1956	July 29 1955	Change	% Change
East Coast	37.006	39.205	— 2.199	— 5.6
Gulf Coast	21.569	19.222	+ 2.347	+ 12.2
Total Coastal	58.575	58.427	+ .148	+ 2.5
Appalachian	3.141	3.546	— .405	— 11.4
Ind.-Ill.-Ky.	19.347	22.846	— 3.499	— 15.3
Okla.-Kans.-Mo.	14.571	12.959	+ 1.612	+ 12.4
Other Inland	6.429	6.891	— .462	— 6.7
Total Inland	43.488	46.242	— 2.754	— 6.0
Total East of Calif.	102.063	104.669	— 2.606	— 2.5
California	11.537	11.267	+ .270	+ 2.4
Total U. S.	113.600	115.936	— 2.336	— 2.0

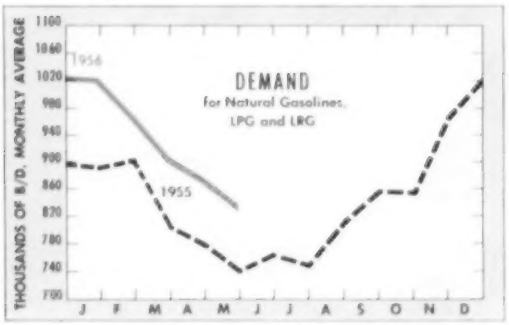
KEROSINE STOCKS
(Millions of bbl on date shown)

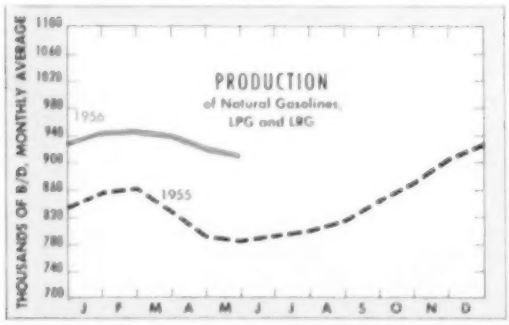
July 27 1956	July 29 1955	Change	% Change
10.829	12.507	— 1.678	— 13.4
6.205	6.109	+ .096	+ 1.6
17.034	18.616	— 1.582	— 8.5
1.294	1.133	+ .161	+ 14.2
6.361	8.113	— 1.752	— 21.6
2.308	2.144	+ .164	+ 7.6
1.486	1.677	— .191	— 11.4
11.449	13.067	— 1.618	— 12.4
28.483	31.683	— 3.200	— 10.1
.400	.317	+ .083	+ 26.2
28.883	32.000	— 3.117	— 9.7

TOTAL MIDDLE DISTILLATE STOCKS
(Millions of bbl on date shown)

July 27 1956	July 29 1955	Change	% Change
47.835	51.712	— 3.877	— 7.5
27.774	25.331	+ 2.443	+ 9.6
75.609	77.043	— 1.434	— 1.9
4.435	4.679	— .244	— 5.2
25.708	30.959	— 5.251	— 17.0
16.879	15.103	+ 1.776	+ 11.7
7.915	8.568	— .653	— 7.6
54.937	59.309	— 4.372	— 7.4
130.546	136.352	— 5.806	— 4.3
11.937	11.584	+ .353	+ 3.0
142.483	147.936	— 5.453	— 3.7

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS
(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	May 1956	Apr. 1956	May 1955
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	380	396	317
Natural Gasoline and Isopentane	297	289	280
Condensate	24	22	15
Finished Gasoline, Naphtha and other	58	63	59
Total Natural Gasoline and Cycling Plant Production	759	770	671
Liquefied Refinery Gases	143	146	111
Total Marketable Gas Liquids	902	916	782
Lease Condensate	125	129	111
Total Natural Gas Liquids	1,027	1,045	893
CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	449	497	371
Natural Gasoline, Isopentane and Other	380	370	366
Total Marketable Gas Liquids	829	867	737

CUMULATIVE PRODUCTION (1000 bbl)	May 1956	May 1955
LPG and LRG	84,604	70,885
Natural Gasoline, Isopentane and Other	56,806	53,860
Total Marketable Gas Liquids	141,410	124,745
CUMULATIVE DEMAND (1000 bbl)		
LPG and LRG	82,955	70,008
Natural Gasoline, Isopentane and Other	55,951	53,726
Total Marketable Gas Liquids	138,906	123,734

STOCKS (1000 bbl, end of month)	May 1956	Apr. 1956	May 1955
LPG and LRG	9,387	7,092	8,634
Natural Gasoline, Isopentane and Other	5,339	5,355	4,792
Total Stocks	14,726	12,447	13,426

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

ADSORBENT, for alkylation units, data and samples; Minerals & Chemicals Corp. See adv't. p. 225.

AGITATORS, side entering, outside packed, bulletin; Patterson Foundry & Machine Co. See adv't. p. 216.

ALLOYS, corrosion resistant, available in standard forms, samples; Haynes Stellite Co. See adv't. p. 62.

ANALYSIS of light hydrocarbons, booklet 82; Burrell Corp. See adv't. p. 238.

AUTOCLAVE, glassed steel, bulletin 939; Pfaudler Co. See adv't. p 223.

BORON TRIFLUORIDE, catalyst, information; Baker & Adamson, Allied Chemical & Dye Corp. See adv't. cover 3.

CASTABLE PLACEMENT, by extrusion, booklet; Mexico Refractories Co. See adv't. p. 56.

CATALYSTS, preformed, booklet; Harshaw Chemical Co. adv't. p. 1.

CLEANING COMPOUNDS, for towers and other equipment, booklet 7629; Oakite Products, Inc. See adv't. p. 224.

COMPRESSORS, centrifugal, gas, booklet; Carrier Corp. See adv't. p. 76.

CORROSION INHIBITORS, propargyl alcohol, technical data; General Aniline & Film Corp. See adv't. p. 64.

DEMISTERS, wire mesh, bulletin 17; Otto York Co., Inc. See adv't. p. 90.

DRYING EQUIPMENT, dehydrators, bulletin 129; Selas Corp. of America. See adv't. p. 72.

DRYING EQUIPMENT for gases, molecular sieves, data sheets; Linde Air Products Co. See adv't. p. 86.

ELECTRICAL SYSTEMS, for control of equipment, bulletin GED-2244; General Electric Co. See adv't. pp. 34-35.

ENGINEERING CONSULTANTS, brochure describes facilities; C. W. Nofsinger Co. See adv't. p. 184.

ENTRAINMENT SEPARATION, wire mesh, bulletin 203; Scjuyler Mfg. Corp. See adv't. p. 78.

ETHANOLAMINES, information and samples; Olin Mathieson Chemical Corp. See adv't p. 74.

EXPANSION JOINTS, bellows, catalog; Solar Aircraft Co. See adv't. p. 170.

FITTINGS, unions, forged steel, catalog 56; Catawissa Valve & Fittings Co. See adv't. p. 228.

FITTINGS, swaged, catalog; Crawford Fittings Co. See adv't. p. 213.

FITTINGS, forged steel, catalogs; W-S Fittings Div., H. K. Porter Co., Inc. See adv't. p. 43.

FLOW ALARM, vibration proof, catalog 10-A-84; Fischer & Porter Co. See adv't. p. 215.

FLOW CONTROL SYSTEM, automatic, jacketed, bulletins F1-56 & J-56; Hetherington & Berner, Inc. See adv't. p. 230.

FURFURAL, for solvent extraction, bulletin 203-A; Quaker Oats Co. See adv't. p. 49.

FURNACES, for ethylene production, bulletin 129 and article reprint; Selas Corp. of America. See adv't. p. 73.

GAGES AND VALVES, liquid level, data; Jerguson Gage & Valve Co. See adv't. p. 174.

GAGES, steel or iron, catalog; Ernst Water Column & Gage Co. See adv't. p. 200.

GAS STORAGE and transportation vessels, brochure; Harrisburg Steel Co. See adv't. p. 177.

GRATING, welded, catalog; Standard Steel Spring Div. See adv't. p. 236.

HEAT EXCHANGERS, scraped surface, bulletin PE-1; Henry Vogt Machine Co. See adv't. p. 75.

HEAT EXCHANGERS, evaporative cooling, bulletin 120; Niagara Blower Co. See adv't. p. 226.

INSTRUMENTS, control panel installations, bulletin 98268; Taylor Instrument Cos. See adv't. pp. 52-53.

INSULATION, industrial, colored, folder and data sheets; Benjamin Foster Co. See adv't. p. 189.

INSULATION, pipe, molded glass fiber, brochure; Gustin-Bacon Mfg. Co. See adv't. p. 38.

MATERIALS HANDLING, truck, side loading, bulletin 1360; Baker-Raulang Co. See adv't. p. 28.

METERING, proportioning and blending equipment, catalogs; Bowser, Inc. See adv't. p. 230.

MIST ELIMINATORS, bulletin ME-6; Metal Textile Corp. See adv't. p. 227.

MIXERS, side and top entering, eight catalogs; Mixing Equipment Co., Inc. See adv't. p. 94.

Information Offered

MOTOR STARTERS, 2200-5000 volt, booklet 1062-VIII, E. C. & M. Div., Square D Co. See adv't. p. 222.

PACKINGS, semi-metallic, catalog 54; U. S. Gasket Co. See adv't. p. 176.

PIPE, Saran lined, for corrosive service, information, Dow Chemical Co. See adv't. p. 231.

PRESSURE VESSELS, fabrication of heavy equipment, booklet; Newport News Shipbuilding & Drydock Co. See adv't. p. 93.

PROCESS EQUIPMENT, built and serviced, bulletins; Condenser Service & Engr. Co., Inc. See adv't. p. 234.

PUMPS, centrifugal, induction motor, bulletin 120-E; Eastern Industries, Inc. See adv't. p. 218.

PUMPS, vertical, bottom dismantling, bulletin 109; Bingham Pump Co. See adv't. pp. 60-61.

STEAM TRAPS, bulletin; V. D. Anderson Co. See adv't. p. 232.

STEAM TRAPS, booklet and magazine; Armstrong Machine Works. See adv't. pp. 88-89.

STEAM TRAPS, impulse type, bulletin; Yarnall-Waring Co. See adv't. p. 70.

STEEL PLATE, alloy, technical data; Lukens Steel Co. See adv't. p. 239.

TUBE MAINTENANCE equipment, cutters, bulletin 59; Airetool Mfg. Co. See adv't. p. 214.

TUBE MAINTENANCE equipment, catalog 81; Gustav Wiedeke Co. See adv't. p. 238.

TUBES, duplex metal, handbook; Bridgeport Brass Co. See ad'vt. p. 79.

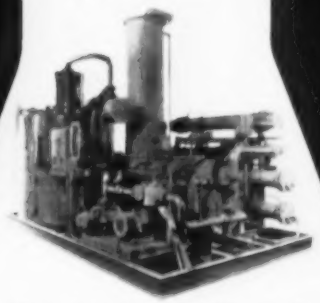
TURBINES, high speed, for compressors and blowers, bulletin 1966; Worthington Corp. See adv't. pp. 26-27.

VALVES, pumps, alloys, literature, charts and catalogs; Cooper Alloy Corp. See adv't. p. 69.

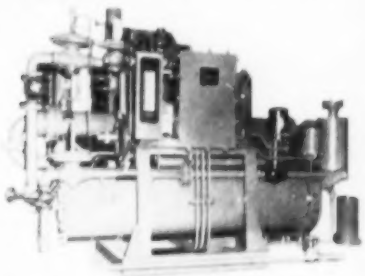
VALVES, wedge, catalog; Hamer Valves, Inc. See adv't. p. 186.

Gas Atmospheres is moving fast with Petrochemical Progress

Pace setting gas generation systems boost quality, safety in petrochemical production



Gas Atmospheres Hi-Purity Nitrogen Generators are available in capacities from 250 SCFH to 40,000 SCFH.



Gas Atmospheres Inert Gas Generators are available in single unit capacities from 250 SCFH to 150,000 SCFH.

No other generator manufacturer surpasses the ability and experience of Gas Atmospheres in producing complete systems for petrochemical processing. Gas Atmospheres Hi-Purity Nitrogen and Inert Systems are being used by most leading petrochemical processors for blanketing, purging or packaging such products as acetone, methanol, formaldehyde, acetaldehyde, butadiene, synthetic fibers, etc.

gas Atmospheres, inc

equipment for producing industrial gases

20011 WEST LAKE ROAD CLEVELAND 16, OHIO

FOR INFORMATION ON ANY PRODUCT OR SERVICE IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products, or services which interest him. This code letter appears in parantheses following the advertiser's name.

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

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- **Chemical Treating of Petroleum Fuels**—to remove and/or convert impurities. 24-pages—$0.75: Circle **R12**

- **The Heat Exchanger**—Special Report on design, costs and types. 32-pages—$1.00: Circle **R8**

- **Vaporization Equilibrium Constant and Activity Coefficient Charts.** 48-pages—$1.50: Circle **R1**

- **Catalytic Reforming Survey**—Special Report on installations and processes. 48-pages—$0.75: Circle **R3**

- **Clip•n•File Sheets**—$0.20 each, any 6 for $1.00. Process Data Sheets **(PDS's)** are 3-page fold-outs. Engineering Data Sheets **(EDS's)** are 2 pages on special heavy paper for repeated handling and reference.

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Prices for quantity orders furnished on request

WHAT'S NEW...

Aluminized Fabric

Protects Worker From Intense Heat

An emergency suit for repairs, fire fighting or specific hot jobs was recently demonstrated in a 1,200°F furnace to show its ability to reflect heat. To dramatize the intense heat from which he was protected, an engineer wearing an aluminum-coated suit walked into the oven carrying wood which burst into flames while he was holding it.

The high-temperature suit is made of a fiber-glass material coated with aluminum and backed up with fiber-glass quilting. Nine-tenths of the heat is reflected away by the aluminum coating and the little heat that gets through is dissipated by the layer of glass fiber quilting.

Other similar garments are produced from aluminum-coated light asbestos (1.2-lb herringbone, Underwriter's grade), aluminum-coated cotton duck, and aluminum-coated glass fiber material backed by a layer of rubber for fire fighting.

The new fabric has been evaluated in more than 2,000 garments in industrial plants during the past year, and has been used in emergency action for fire-fighting and critical repairs of hot equipment. Twelve manufacturers of industrial clothing are now offering many articles of clothing made from this fabric. The aluminizing process is done by **Minnesota Mining and Manufacturing Co.,** 900 Fauquier St., St. Paul 6, Minn.

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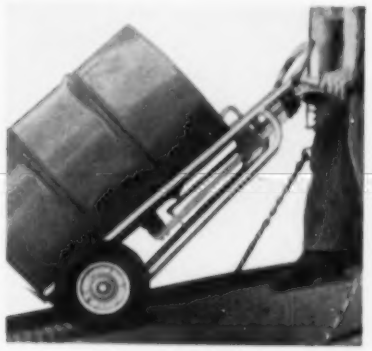

All Aluminum Barrel Truck

. . . **has two wheel brakes** which can be operated like an English bike.

With a tubular frame of heavy aluminum pipe (for non-sparking), this easily handled barrel cart has a guaranteed load capacity of 1000 lb. The wheels are equipped with ball bearings and available with solid or pneumatic tires. Short handles with rubber grips allow easy turning inside truck or car bodies during loading. The truck itself is light enough to be lifted by an operator. **Valley Craft Products, Inc.,** Lake City, Minn.

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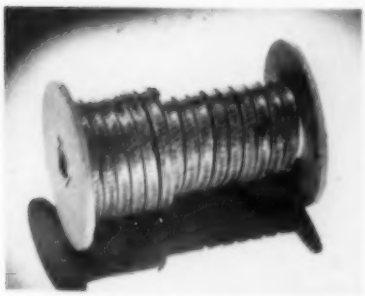

Mechanical Packing

. . . **of glass and Teflon** is highly resistant to corrosion and moderately high temperatures.

Constructed of pure Teflon fibers over a core of glass fibers, and then impregnated with Teflon, the packing is soft and pliable for use on centrifugal as well as reciprocating and static applications. It resists the corrosive action of sulfuric and nitric acids, sodium hydroxide, aqua regia and practically all solvents. **Abbot & Biddle,** 2417 Federal St., Philadelphia 46, Pa.

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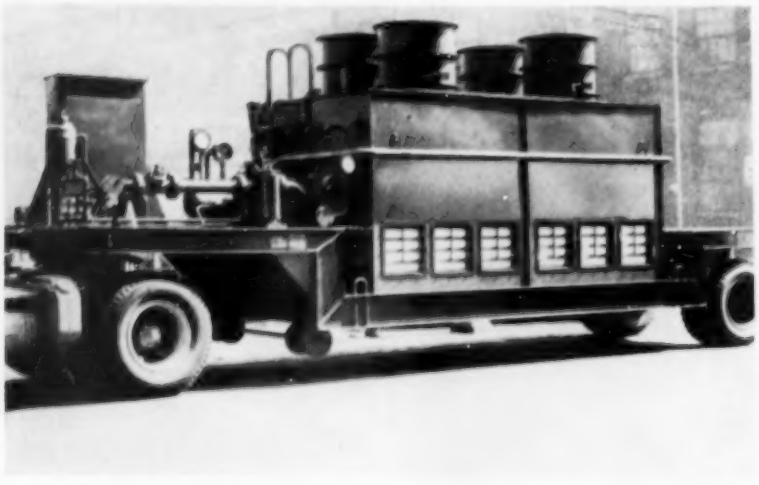

Portable Water Cooler

Conserves Water In Critical Areas

A portable water-cooling tower may be the answer to industrial situations where limited cooling-water supplies have hampered production. Although developed for use with portable oxygen-generating plants in remote locations, this trailer-transported cooling unit can be used in other water-starved areas.

It is a complete package on wheels. Compact and lightweight, the cooling unit is equipped with all necessary accessories such as pumps, strainers, electrical control equipment, pressure gages, thermometers, and feed water conditioner. Design capacity is 240 gal/min of 115°F water reduced to 90°F when operating at 95°F air temperature and 80°F wet bulb.

The tower pictured is made of steel and packed with 20-inch Fiberglas. The entrainment separator is a special copper mesh, and the four axial flow fans have a capacity of 11,000 cfm each. The entire cooling unit is shipped as a unit. **Badger Manufacturing Co.,** Cambridge, Mass.

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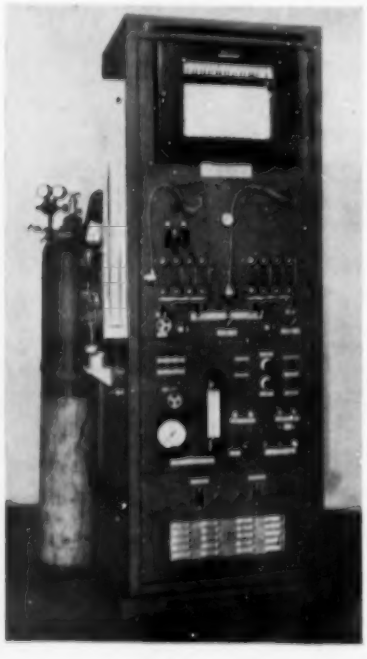


Mobile Chromagraph

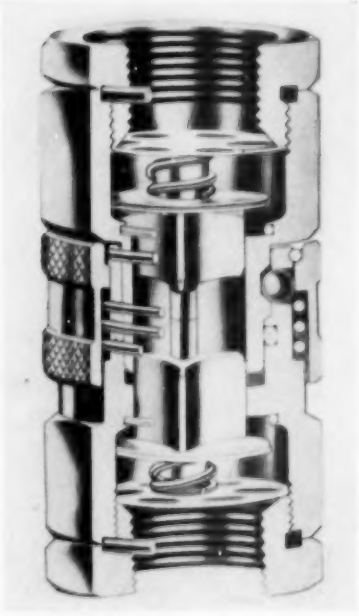
. . . **is completely self-contained** and occupies a floor space of 30 x 26 in., exclusive of the carrier gas tank.

The Model 1111A Chromagraph embodies the best features of the many apparatuses evolved in several years of research in this field at Shell Development Co. in Emeryville, California. Separation of isomers is readily handled at temperatures down to zero °C with a self-contained refrigerating unit. Materials boiling at temperatures approaching 400°C can be analyzed at operating temperatures of 250°C and higher. The instrument has been successfully applied to the analysis of full-range cracked gas, other saturated or aromatic compounds, oxygenated and halogenated compounds, various alcohols and aldehydes, light aliphatic acids and esters, and other compounds.

Plug-in panels are used, each of which is complete with column and detector. Any column size up to 50 ft of ¾ in. diameter tubing can be accommodated. Carrier gas pressure is adjustable from 0-30 psig with self-contained regulator and pressure gage.

A special electronic strip chart recorder of 1 mv sensitivity and 2-second pen speed is provided. An accurate ball and disc integrator draws pips easy to count on the right margin of the chart. **Hallikainen Instruments,** 1341 Seventh St., Berkeley 10, Calif.

Circle No. **5** *on Reply Card*



Quick Coupling

. . . **uses Teflon nipple and seals** and permits a quick coupling attachment for acids, alkali, solvents and high-pressure steam.

Known as the "HK" coupling, it will function through a temperature range of —100 to +500°F, and it may be subject to extreme temperatures for short periods. Manufactured from solid bar stock, it can be furnished in 303 and 316 stainless steels, brass, aluminum, special carbon steel or other machineable material.

The coupling is available with or without automatic shut-off valves incorporated in either or both ends. This valve arrangement will shut off the valved end of the line immediately when the disconnection is made. The valve opens automatically when the coupling is connected. Sizes are available from ½ through 3-in. I.D., with any type of end connection which is desired. **Snap-Tite, Inc.,** Union City, Pa.

Circle No. **6** *on Reply Card*

Unique Point Indicator

Reduces Computing and Layout Time

Called the Miracle Point Indicator, this instrument is a combination angle-finding, center-locating, and leveling device for shop and field use. It consists of a mercury-balanced level and a degree-calibrated dial, enclosed and mounted on a magnetized V-base.

Two Alnico-V magnets in the base hold the indicator in contact with metallic objects, such as pipes or conduits to be joined, and leaves the worker's hands free to adjust the work to the correct angle. To find the center of a round object, the indicator is placed astride it and turned until the dial reads zero. The V-base junction then indicates the exact center.

Similarly, points can be located at any angle on material to be worked without measuring, computing or scribing. The indicator is placed on the object and turned until the dial reads the desired angle. The center punch then indicates the correct point location. Accuracy is within 3 minutes of a degree. **Racine Instrument Co.,** 500 College Ave., Racine, Wis.

Circle No. **7** *on Reply Card*

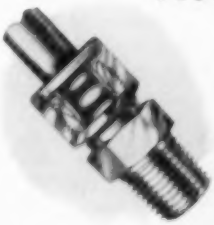
Nylon Tubing

. . . now available in sizes up to 1½-in. O.D., will not soften up to 225°F and resists attack by many chemicals.

Made from two types of nylon—66-nylon and caprolactam—the new pipe is resistant to esters, ketones, common solvents and weak acids. It is not resistant to phenol, formic acid and concentrated mineral acids. Petroleum oils and greases at temperatures as high as 300°F have little effect on the tubing.

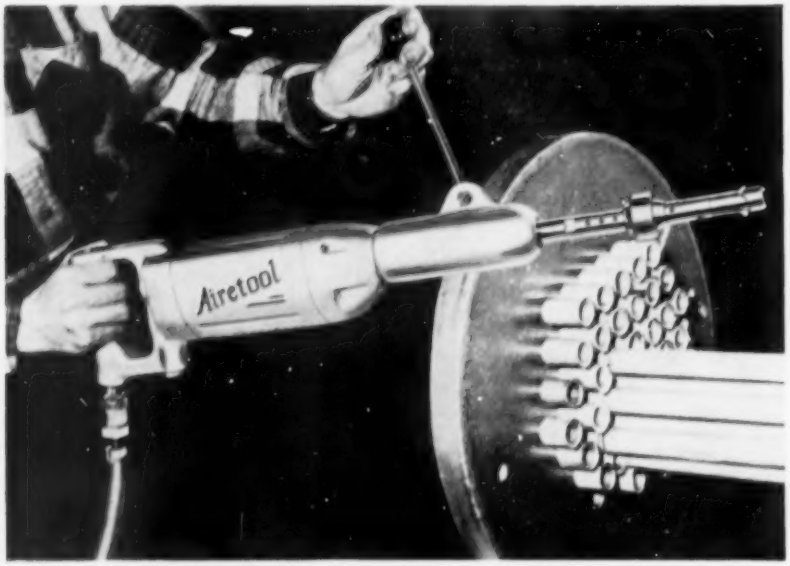
Since nylon has a rather sharp melting point, rather than a gradual softening temperature range, it loses little of its desirable properties at elevated temperatures. Nylon tubing is available in a range from ⅜- to 1½-in O.D.

BIG SALE!
Replacement Human Hands
FOR MEN WHO IGNORE SAFETY REGULATIONS!
We think it is smarter to play safe. Observe all safety rules and use
Swagelok®
FITTINGS



GET ALL THE FACTS: Write for the Swagelok catalog. Address Dept. D9
CRAWFORD FITTING CO.
884 EAST 140th STREET
CLEVELAND 10, OHIO

CUTS TUBES FASTER!



AIRETOOL'S NEW air-driven internal tube cutter

AIRETOOL'S new, lightweight, portable tube cutter removes damaged or leaky heat exchanger and condenser tubes faster and more economically than ever before. Self-centering, double-action, hardened steel tool bits cut nonferrous and steel tubes ⅝" to 1" in diameter, through tube sheets 1" to 4" thick. Operator governs rate of cut through positive feed control, eliminating gouging or burning and increasing life of tool bits. The new single-stage air-driven motor, designed and precision built by AIRETOOL, is powerful and easy to use. Available in speeds of 200, 265, 335 and 625 r.p.m.

AIRETOOL'S new tube cutter is also available with electric driven motor for use where air supply is not available, and in a push-type design which can be adapted for use with your own electric or air motors. AIRETOOL Internal Tube Cutters are an economical necessity, invaluable for tube maintenance programs.

Send for Bulletin #59, illustrating the complete new line of AIRETOOL tube cutters, cleaners, expanders, accessory and specialty tools.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge

REPRESENTATIVES in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan Hawaii. EUROPEAN PLANT: Vlaardingen, The Netherlands

Wall thicknesses vary from 0.025- to 0.125-in. It is easily assembled with commercial fittings. **Danielson Manufacturing Co.,** Danielson, Conn.

Circle No. **8** *on Reply Card*

Gas Analyzer

. . . **measures many process stream gases** such as carbon dioxide, hydrogen, ammonia and others. Analysis is by thermal conductivity.

The instrument is available with single or multiple range, plus a choice of three outputs for using a recorder or indicator. It is also available with an auxiliary amplifier for current output or with air output through an electro-pneumatic transducer.

The Moled 7C Analyzer has the operating controls and indicating meter conveniently located on the case panel. Explosion-resistant condulet mounting is available. **Arnold O. Beckman, Inc.,** 1020 Mission St., South Pasadena, Calif.

Circle No. **9** *on Reply Card*

Corrosion Tester

. . . **measures rate of corrosion** of liquids and gases on all types of metals. In the space of a few hours it is possible to predict corrosion that may require five or ten years under actual conditions.

Basically the instrument is a sensitive Wheatstone bridge circuit. Probes have one protected corrosion strip and

one exposed strip. Automatic temperature compensation is obtained from the protected strip. The corrosion on the unprotected strip is indicated directly on the meter in micro inches. The probes are designed for either high or low temperatures testing, lab or field, or short or long test periods.

All controls are housed in a steel case, fully enclosed from corrosive atmospheres. Standard models are wired for 115 volts, 60 cycles ac, but may be obtained with a dc converter for field work. **Labline, Inc.**, 3070-82 W. Grand Ave., Chicago 22, Ill.

Circle No. **10** *on Reply Card*

Self-Reading Tape Rule

. . . **shows complete measurements** to fraction of an inch on a vernier dial. A self contained serrated wheel can be used as a scriber to mark a dimension after it is made.

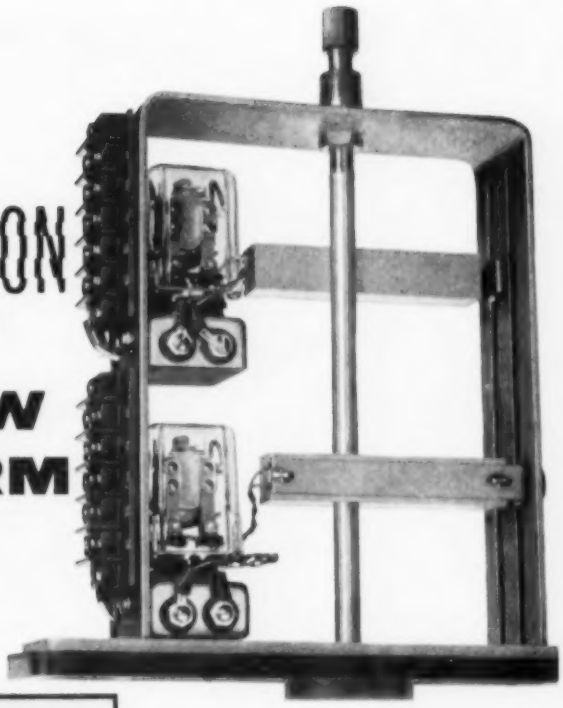
The triple coated white-face tape extends to 78-in. and is counter balanced with an inner spring for smooth return to the case. Built in pads clean and oil the tape each time it is used. Moveable end-clip on the tape compensates for "hook" or "butt" measurement. The case is made of die-cast, highly polished chrome plate. **Frederick Post Co.** 3650 N. Avondale Ave., Chicago 18, Ill.

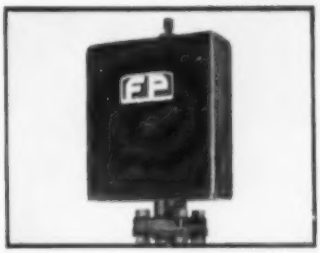
Circle No. **11** *on Reply Card*

Dock Hose

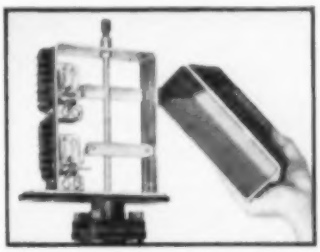
. . . **uses aluminum reinforcement** to reduce weight but will still handle pressure of 200 psi. A section of 4-in.

VIBRATION *proof* FLOW ALARM

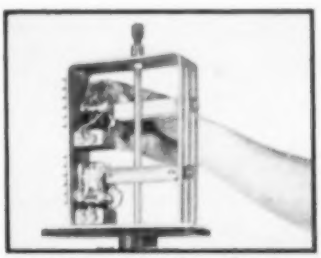




Ratolarm with cover on



Ratolarm with cover removed



Relays are easily replaced

At last a low cost flow alarm immune to vibration. For linear scale flowmeters and liquid level applications.

Snap-action electrical contacts are hermetically sealed in glass. Contact closure can be made *only* by passage of the magnetic float extension rod. False alarms are eliminated.

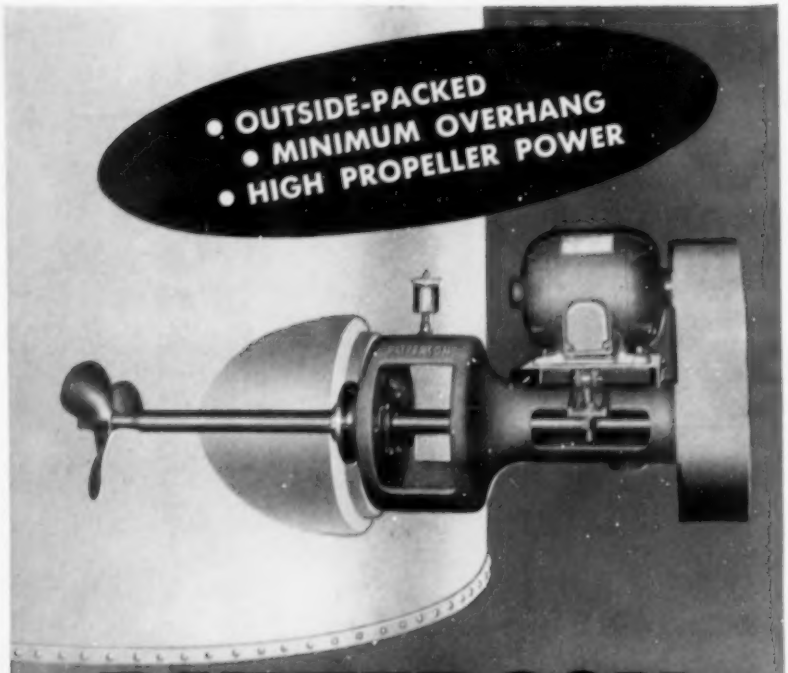
Consider these advantages:

- Rugged, vibration-proof, glass-sealed switch
- High, low or double alarm, adjustable to any scale position
- Dependable, long life, low cost, no electronic parts
- Explosion-proof construction available
- Plastic enclosed plug-in relays for easy maintenance

Write today for complete information. Ask for catalog 10-A-84.

FP FISCHER & PORTER CO.

LA1086 **3996 County Line Road, Hatboro, Penna.**



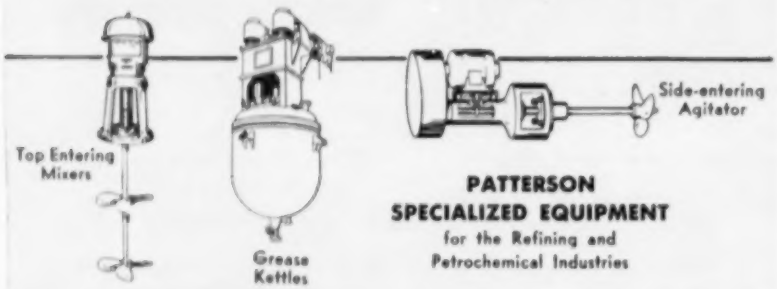
PATTERSON

SIDE-ENTERING AGITATORS

V-BELT • GEARED • GEAR MOTOR

Compact, simple and sturdy Patterson Side-Entering Agitators meet the highest standards for continuously dependable performance. Outside packing is replaceable with tank full. Short overall length. Get the facts —send for latest Bulletin!

Richard L. Cameron
President



PATTERSON SPECIALIZED EQUIPMENT
for the Refining and Petrochemical Industries

The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
NEW YORK, BOSTON, BALTIMORE, PHILADELPHIA, PITTSBURGH, DETROIT, CINCINNATI, ATLANTA, CHICAGO, ST. LOUIS, HOUSTON, DENVER, LOS ANGELES, SAN FRANCISCO, SEATTLE

The Patterson Foundry and Machine Company, (Canada) Limited
Toronto, Canada
MONTREAL

What's New!

"Boston Aluminum" hose weighs only 8 lb/ft and has integral cast aluminum flanges and aluminum nipples. The outer covering is synthetic rubber meant to withstand tough handling.

Three other new types of hoses for loading and unloading are also available. *Bull Dog 200* is a rough bore hose using steel wire reinforcement and weighing 11 lb/ft. It is recommended for heavy-duty unloading or loading using pressures up to 200 psi. *Boston 200 Lightweight* is a smooth bore hose weighing only 5.7 lb/ft for the 4-in. size and capable of withstanding 200 psi. A still lighter hose for moderate unloading duty is the *Boston 100 Lightweight*, a smooth bore hose weighing only 4.2 lb/ft. All hoses are available in sizes from 4 in. to 12 in. inside diameter. **Boston Woven Hose & Rubber Co.**, P.O. Box 1071, Boston 3, Mass.

Circle No. **12** *on Reply Card*

Ventilated Safety Suit

. . . **permits working in 175°F** conditions for as long as 100 minutes. Normally 150°F is top exposure—and then for shorter working periods of about 20 minutes.

The ventilated clothing consists of a pair of coveralls made from flame resistant cotton, Dynel or other fabric. At the back of the coveralls is a removable air manifold from which air is distributed through flat, flexible

NOW PETROLEUM PROCESSING CAN BECOME AN ATTRACTIVE PERMANENT PART OF YOUR BUSINESS OR HOME LIBRARY

These Jesse Jones files, especially designed for *Petroleum Processing* keep your copies orderly, readily accessible for future reference. Guard against soiling, tearing, wear or misplacement of copies.

Each Jesse Jones file will keep one year's copies of *Petroleum Processing* in perfect condition.

No irritating wires to handle—Allows any copy to be removed.

These durable files (will support 150 lbs) come in a rich orange and black Kivar cover. Looks and feels like leather and is washable. The 16-carat gold lettering makes it a fit companion for the most costly binding.

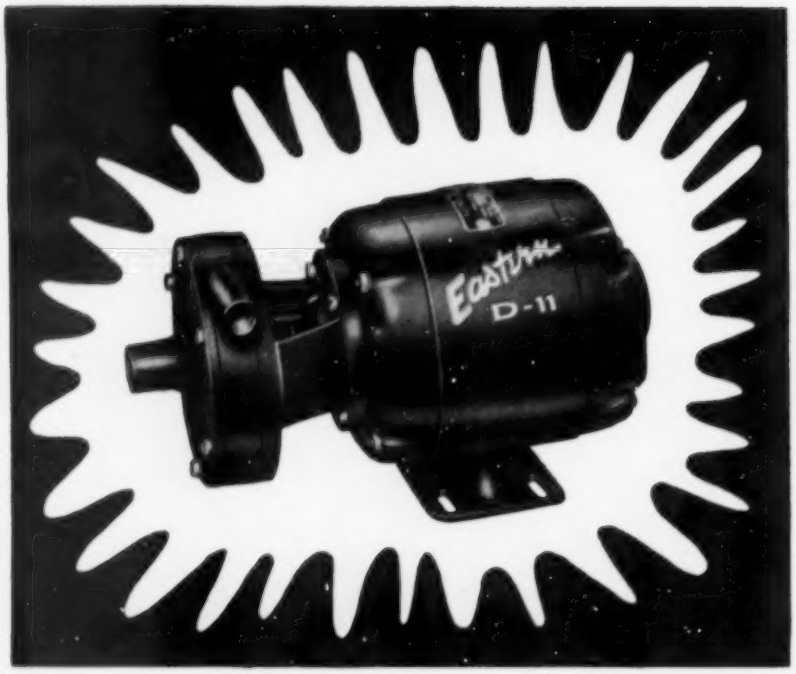
Reasonably priced, too. Only $2.50 each, 3 for $7.00, 6 for $13.00, POSTPAID. Add $1.00 postage for orders outside U.S. *Satisfaction unconditionally guaranteed or your money back.*

For prompt shipment of these attractive files, use coupon below.

Jesse Jones Box Corporation, Dept. P.P.
P. O. Box 5120
Philadelphia 41, Penna.

Please send me, postpaid, _____ *Petroleum Processing* files.
I enclose _____. Bill Me ☐
Name _____
Address _____
City _____ State _____

 (To obtain more data on advertised products see page 208)



24,830 successful installations!

EASTERN D-11 CENTRIFUGAL PUMP

Why is the D-11 so successful among original equipment manufacturers? *Size and weight* make it ideal. The D-11 is the smallest, close-coupled, single-stage centrifugal pump available with an induction type motor. Eighteen pounds of compact design (9¾" x 4⅝") make it excel in industrial and process equipment, as well as laboratory service, and pilot plant operations.

SPECIAL METALS

A full selection of metals make the D-11 and other Eastern Centrifugal Pumps versatile performers. Available in 18-8 Type 303 and Type 316 Stainless Steel, Monel, Hastelloy "C", Cast Iron and Bronze, Eastern Pumps range from ⅛th to ¾ H.P. with capacities up to 70 G.P.M., pressures to 65 P.S.I.

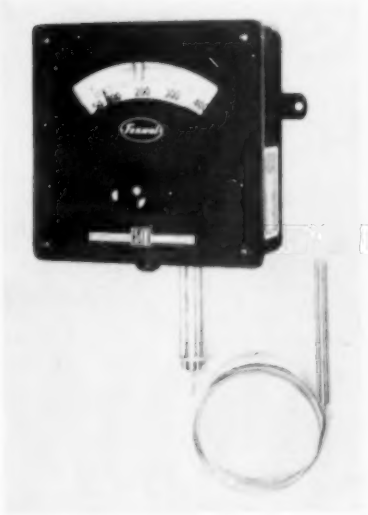
For complete specifications on all Eastern Centrifugal Pumps, request Bulletin 120-E

Eastern INDUSTRIES, INC.
100 Skiff St., Hamden 14, Conn.

tubes. Air at 90 to 110 psig is supplied to a ½-in. hose; flow is 200 to 250 cfm. By increasing the o.d. of the tube and hose connector leading to the aluminum manifold, the rate of flow can be changed to maintain comfortable working conditions.

A D-ring located between the shoulders of the coveralls for attaching a life line capable of pulling 400 lb. A safety helmet and hood are available for use with the ventilated suit, with air flow at the neckline regulated for circulating air under the hood. **Union Industrial Equipment Corp.,** 175 Main St., White Plains, N. Y.

Circle No. **13** *on Reply Card*

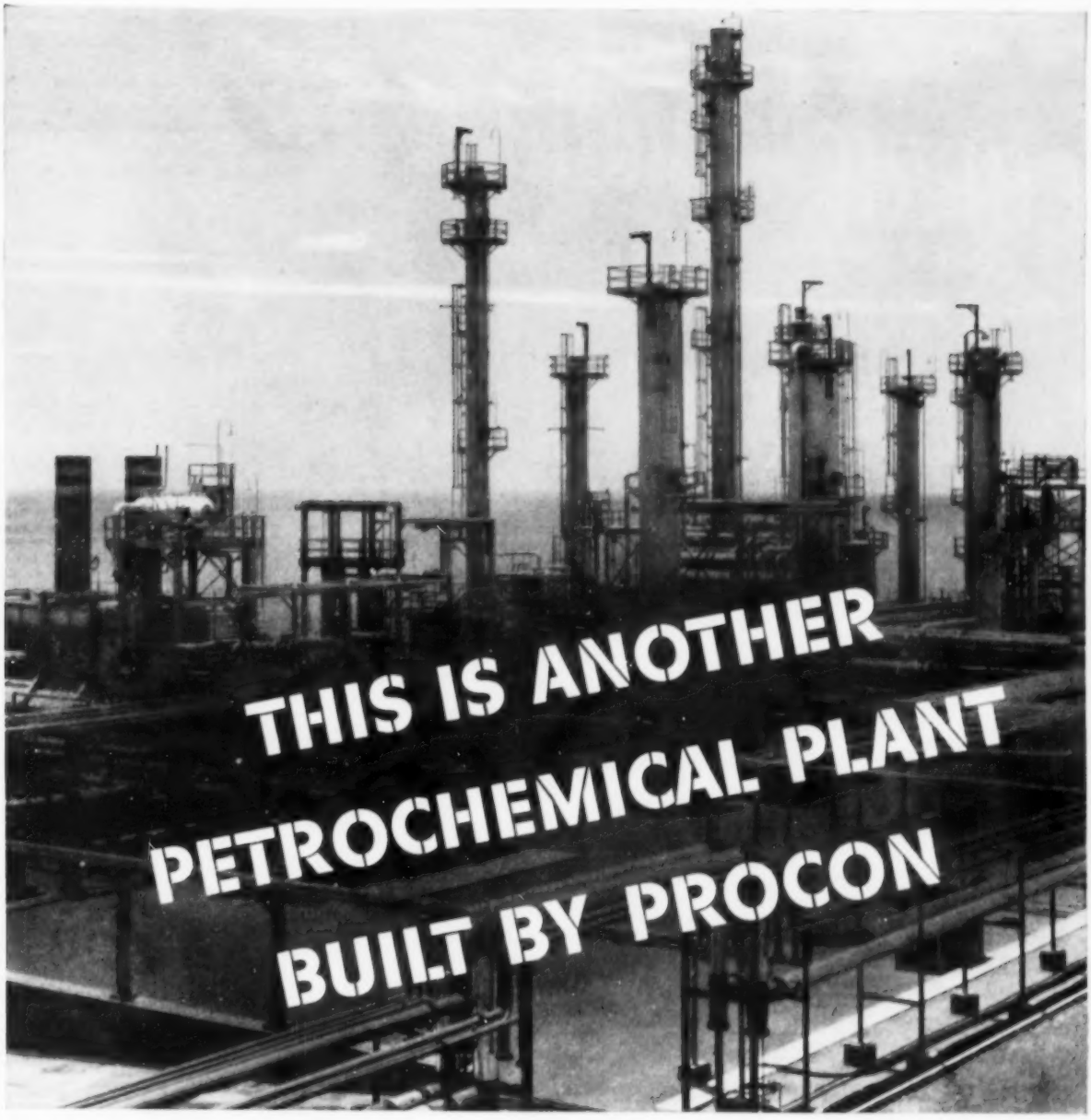


Temperature Controller

. . . **uses interchangeable elements for** tailor-made application, and offers six temperature ranges: —150 to +200°F, 50 to 400°F, 50 to 700°F, —100 to +100°C, 0 to 200°C, and 25 to 375°C.

The controller has two control switches, each with a setpoint indicator, to actuate two separate circuits at the preset temperatures. This permits controlling at one temperature and actuating alarms, auxiliary heating or cooling at a second temperature.

The bulbs of the controller are of stainless steel with thin walls for maximum response speed. The capillary tubing is of stainless steel or nickel-plated copper. A swivel-mounted assembly prevents breakage of the bulb-and-capillary by accidental twisting. Bulb temperature is indicated by a pointer traversing the lower half of the dial face and permits visual comparison with the control setting pointer on



This fine plant overseas is just one example of Procon's continually growing accomplishments in petrochemical construction. Like all our projects, it was completed on schedule and up to every specification.

Procon's world-wide construction organization provides a complete service, including new plant construction, additional process facilities, expansion or modernization, to the petrochemical, chemical and oil refining industries. Our services are available to you, any time, anywhere.

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U.S.A.

PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA
PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND
PROCON INTERNATIONAL S. A., SANTIAGO DE CUBA

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

 (To obtain more data on advertised products see page 208)

TC

CUPRIC CHLORIDE

MADE FROM VIRGIN COPPER FROM OUR OWN MINES

PRODUCED BY THE

TENNESSEE CORPORATION

MINERS OF COPPER, ZINC, IRON AND SULPHUR

A SUPERIOR SWEETENING REAGENT IN PETROLEUM REFINING

We are in a position to supply your needs on annual, semi-annual or monthly contract basis—also smaller quantities in drop shipment lots.

CUPRIC CHLORIDE DI-HYDRATE

TC TENNESSEE CORPORATION

TYPICAL ANALYSIS

Copper	37.00% minimum
Moisture	12.00% maximum
Fe	.04% maximum
Zn	.01% maximum
Copper Oxychloride—less than	.50% maximum

CHECK THESE FEATURES

High Copper Content
Lower Moisture
Uniform Particle Size
Uniformity
Availability
For
1. Quality Improvement
2. Cost Reduction

Other Tennessee Corporation products:
Ferric Sulfate (Ferri-Floc),
Copper Sulfate
and
Sulfur Dioxide.

For samples make request on your company letterhead.

TENNESSEE TC CORPORATION

617-627 Grant Building, Atlanta, Ga.

YOUR ORGANIZATION

Is it complete?
Are you expanding it?
Making Replacements?

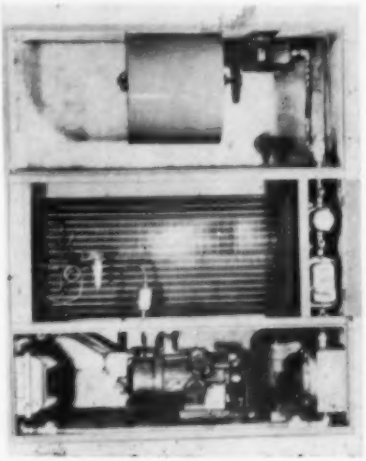
Naturally, you are anxious to secure the most suitable man or men available. You want men with the special training that will make them an asset to your organization. You can contact such men through an advertisement in the Classified Section of Petroleum Processing. For information write:

PETROLEUM PROCESSING

330 West 42nd Street New York 36, New York

the upper half of the same dial. Accuracy is within ±2° under optimum conditions. **Fenwal Incorporated,** Ashland, Mass.

Circle No. **14** *on Reply Card*



Air Conditioner

. . . **for hazardous areas** is explosion resistant, suitable for installation in all Class I, Group D areas.

The conditioners use Worthington hermetic compressors, condensers and coils. Each individual electrical component is approved and bears the Underwriters' label, except the motor. The motor is hermetic and under positive gas pressure. Its leads are inspected and approved. Fans are nonsparking with static conducting belts.

The units are available in 3-, 5½-, and 7½-ton sizes. **Conditioned Air, Inc.,** Charleston, West Virginia.

Circle No. **15** *on Reply Card*

Ceramic Fiber Blanket

. . . **resists temperatures up to 2,300°F** and is useful for insulating diesel exhaust, gas turbines, furnace ducts and high-pressure steam lines.

Made of extremely fine, closely in-

a new NICHOLSON STEAM TRAP

for capacities up to 800 lbs.

Model N-125 available through your local distributor, as well as your Nicholson representative.

Now you can have all of the operating advantages of Nicholson design simplicity and rugged construction in the new, competitively priced Model N-125 steam trap for lower capacity applications.

Like other traps in the Nicholson line . . . it combines a unique thermostatic bellows, large orifice, and fast, intermittent valve action to assure effective and economical discharge of condensate and air from steam lines and equipment.

The Model N-125 has a maximum discharge capacity of up to 800 lbs. of condensate per hour at pressures up to 125 lbs. It operates on a temperature differential of only a very few degrees. Its tight, positive shut-off avoids dribbling, leaking, wasting steam.

NICHOLSON

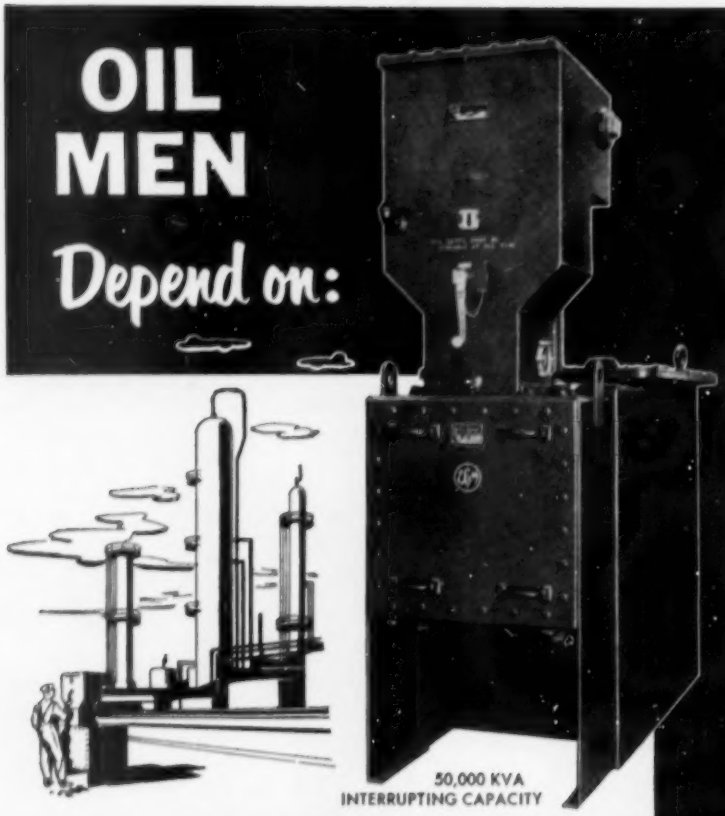
W. H. NICHOLSON and Company

TRAPS • VALVES • FLOATS • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 98 PRINCIPAL CITIES

 (To obtain more data on advertised products see page 208)

OIL MEN Depend on:



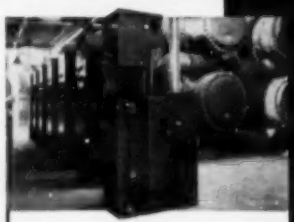
50,000 KVA
INTERRUPTING CAPACITY

EC&M 2200-5000 VOLT Motor Starters

These EC&M Div. 1 combination Starters for Class I, Group D locations give refinery engineers and construction and design companies top value. They require less floor space . . . line, motor and control leads are brought to conduit connection box for quick installation . . . and high interrupting capacity is inherent . . . 50,000 KVA, and no fuses required.

Oil disconnect switch (on top) may be locked open or closed . . . view windows on both sides show switch contacts. Rear oil-tank has potential transformer for 220-volt push button circuit. Type ZHS (50,000 KVA) Magnetic Contactor may be raised above oil for inspection without disconnecting any bolts or leads.

Before buying, investigate EC&M Combination Starters . . . they provide economy in installation, operation and maintenance . . . and they're complete in every respect.



ADVANTAGES of this Battery of EC&M Starters in a refinery.

1. Combination Starter with self-contained Oil Disconnect Switch
2. All internal wiring complete . . . leads brought to conduit box for easy connection to power and motor leads
3. Heavy duty contactor has alloy contacts
4. Slender design reduces floor space
5. Thermal-Magnetic Overload Relays give accurate motor protection . . . trip instantly on faults
6. Simple 3-wire time-delay UVP push button circuit

Write for descriptive Booklet 1062-VIII

SQUARE D COMPANY
EC&M DIVISION • CLEVELAND 28, OHIO

tertwining fibers of aluminum silicate, the Fiberfrax blanket keeps its form and properties despite high temperatures. Insulating values are tabulated as:

Mean Temp. °F	Btu (hr) (sq ft) (°F in.)
600	0.50
1000	0.86
1400	1.29
1800	1.80
2000	2.10

Density of the blanket is assumed at 5 lb/cu ft.

Because of its high chemical stability, Fiberfrax may also be used as insulation lining in refractory furnaces without harm from the furnace atmosphere. It is available in 25 ft, ½-in. thick rolls. **The Carborundum Co.**, Niagara Falls, N. Y

Circle No. **16** *on Reply Card*

Liquid Level Gage

. . . **flashes a red warning light** when level is too high or low. The scale of this gage, designed primarily for remote reading of boiler water level, otherwise is illuminated by two 15-watt bulbs and readable from any point where it can be seen.

The convex face of the *Truscale* gauge has scale markings directly on its face. When the level reaches the alarm points the entire scale is brightly lit by a large red flashing bulb, which continues to flash until the dangerous condition is corrected.

Instant reading of liquid levels of tanks or boilers is possible to an accuracy of ½% of scale reading. The *Truscale* gage may be equipped with

Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., Rochester, N.Y., U.S.A.

A new glassed steel autoclave

Handles reactions up to 750 psi

Your experiments with reactions involving high pressure and corrosive liquids have led to the development of a new, specially designed autoclave – now available to you at Pfaudler.

The new autoclave permits you to conduct reactions where internal pressures go as high as 750 psi with complete safety. Glassed steel construction prevents any undesired catalysis in the product from occurring. And you can study the reaction of highly corrosive liquids with the knowledge that no harm will come to the autoclave.

Since it is constructed of glassed carbon steel, the new autoclave gives you the corrosion resistance of glass and the structural strength necessary to withstand high pressures. Capacities are 1, 2, and 3 gallons.

You get a wide selection of agitation from the variable-speed drive–the two-blade impeller agitator is glassed steel, too. Provision has been made for a thermometer well and the nonmetallic rotary seal is equipped with pneumatic lubrication.

To find out more about these new autoclaves, write to us and ask for Bulletin 939.

ANNOUNCING PFAUDLER'S NEW FILM-TYPE EVAPORATOR

Now you can uncover areas of greater profit with this simple-to-operate still

Pfaudler has added an important new member to its growing family of products – a wiped-film evaporator for vacuum distillation.

It is a new improved evaporator which offers low-cost development opportunities to many industries e.g. chemical process, food, pharmaceutical, plastics, petroleum.

A *floating carbon blade* acted upon by centrifugal force cleanly wipes the peripheral evaporating surface to promote a very thin film and turbulence–creating higher heat transfer rates and faster evaporation.

Here are the benefits you get from using the Pfaudler evaporator:

1. IMPROVED HEAT TRANSFER–Very high heat transfer rates even for highly viscous products due to turbulence promoting carbon blades.
2. SHORT CONTACT TIME–No deterioration for heat sensitive materials.
3. CONSTANT UNIFORM FILM – The walls are wiped by actual contact of the carbon blades. This is the only positive means of inducing controlled turbulence and uniform film thickness. Fouling and solids-build-up are eliminated.
4. LOW-COST PROCESS–Because of the short contact time, high heat transfer rate and low power consumption of this evaporator, your operation can be more efficient and less costly.
5. SPACE SAVING – An internal condenser is built into the still eliminating an external condenser and interconnecting piping.
6. LOW MAINTENANCE RATE – Slow speed wiping minimizes wear. Closely machined tolerances between wall and wiper blades are not necessary because contact between the wiper and the wall is due to centrifugal force. Thermal expansion does not affect the operating efficiency of the wiper blades. No foot bearing is required.
7. LOW PRESSURE DROP – Pressure drops between evaporator and condenser as low as 1/10 mm Hg at one mm Hg operating pressure.

Two models available

Two Inch Laboratory Evaporator, complete with rotor motor, heating mantle, two 500-m.l. receiver flasks, batch-type feed flask, degasser, Teflon wipers, 24/40 standard taper joints.

For 115 volt, 1 phase,
50-60 cycle power $391.00
For 250 volt, 1 phase,
50 cycle power $397.00

Twelve Inch Pilot Plant Evaporator, stainless steel, complete with ¼ HP variable-speed rotor motor, 4 sq. ft. heat transfer surface in jacket, 6 sq. ft. heat transfer surface in internal condenser, vacuums to 0.1 mm or lower, temperatures up to 700 F., very high capacities. For 220 volt, 1 phase, 60 cycle power. (Prices on request.)

Units may be coupled for fractionation. The distributor acts to accelerate the distillate through the evaporator–residence time is less than one second.

In many installations of both the laboratory model and the Twelve Inch Pilot Plant unit, the versatility and high evaporation rate of this new evaporator have been proved. And it has been found that the quality of results from these small units can be dependably duplicated in production size units.

It's easy to test your distilland yourself with the laboratory model. Data you gather will enable you to uncover those areas of greater profit in your own operation. For your needs at that time, Pfaudler offers standard jacketed units in 24-, 36-, 48-, and 60-inch production size models.

Order the Pfaudler Two Inch Laboratory Evaporator now.

Tough Alkylation Unit Yields To Oakite Methods

"Problem" towers cleaned in record time

During a recent turn-around at a large refinery a problem came up when the maintenance crew, working with Oakite materials and methods, reached the 5-tower alkylation unit. Until then everything had gone so smoothly that the turn-around was practically a spin-around.

Now the problem was: how to get rid of every trace of HF acid in the stripper and de-iso towers. This was necessary because plans called for cutting out by torch all the old trays in these two towers and replacing with new trays.

It seemed too much to expect, even from Oakite. But here's what happened. The Oakite Technical Service Representative recommended using Oakite Compound No. 85. This was circulated for 16 hours and then pressure rinsed. Result? Not a trace of acid in the amazingly clean towers — and in addition, a new record was set for speed in this cleaning operation.

Maybe Oakite can help you, too, to set new records for efficient maintenance cleaning. Call your local Oakite man, or write for free booklet 7629. Oakite Products, Inc., 50D Rector Street, New York 6, N. Y.

Export Division
Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

signal horns or other lights so that the warning alarm is sent outside the immediate area of the gage. **Jerguson Gage & Valve Co.**, 80 Fellsway, Somerville 45, Mass.

Circle No. **17** *on Reply Card*

Free Trade Literature

Plastic Pipe and Fittings

. . . and their applications: *Geon 8700-A and 8750* is a booklet intended to acquaint the pipe consumer with the properties of this rigid polyvinyl chloride, and the compounds and applications of its products. Included are two tables which summarize physical properties of the two compounds and tabulate the results of chemical immersion tests. B. F. Goodrich Chemical Co., 446 Rose Building, Clevedand 15, Ohio.

Circle No. **18** *on Reply Card*

Nondestructive Testing

. . . an overall look: *Seeing Isn't Always Believing* is a booklet (new edition) that describes the use of magnetic and other methods for detecting flaws in equipment. Methods explained include magnetic dusting, fluorescent magnetic particles, fluorescent penetrants, electrostatically charged particles, eddy currents, and ultrasonic waves. Magnaflux Corporation, 7300 Lawrence Ave., Chicago 31, Ill.

Circle No. **19** *on Reply Card*

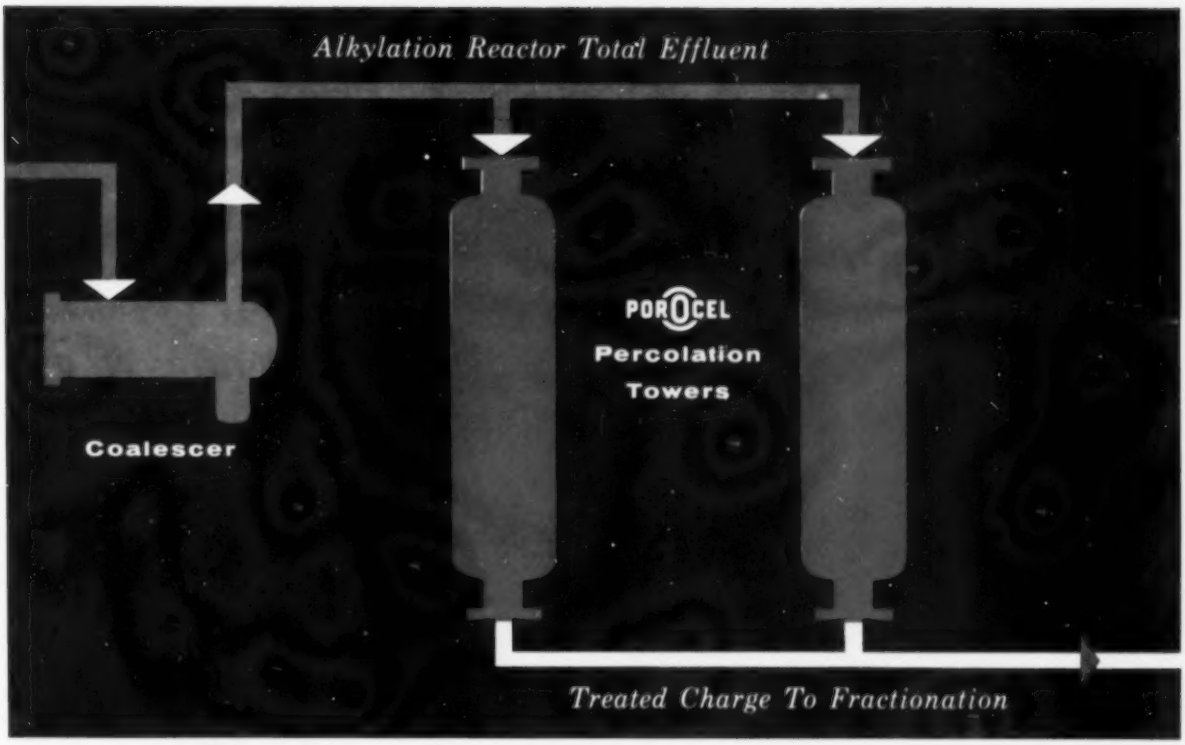
Data Handling Systems

. . . are catalogued in *Short Form Catalog C 703*. Described are engineered systems for data reduction, logging and handling, industrial measuring and recording for process control. Outlined are three new analog computers, plus four components for control systems—amplifiers, electronic multipliers and function generators. Berkeley division of Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif.

Circle No. **20** *on Reply Card*

Steel Tubing Charts

. . . give tolerances, properties, and sizes for "Electrunite" mechanical tubing. 19- x 20-in wall charts, or in pocket-size booklets, these reference



POROCEL adsorbent helps increase capacity, reduce maintenance costs of Alkylation unit

Employed in the new effluent treating technique developed jointly by DX-Sunray Oil Co., and M. W. Kellogg Co., Porocel—M & C's versatile sorptive bauxite—plays an important role in DX-Sunray's Alkylation Unit at West Tulsa.

Straightforward Method—Total H_2SO_4 reactor effluent is handled in a simple 2-tower percolation system—one tower on stream while Porocel in the other undergoes unique in-place regeneration.

Trouble-Free Operation . . . Increased Capacity—Porocel preferentially removes more than 99% of acid and esters as compared with about 65% removal obtained in conventional caustic and water wash systems. This *virtually eliminates* corrosion and fouling in fractionating equipment, provides *sound protection* against maintenance troubles, and permits pushing the unit to higher capacity.

Long Life—In addition to showing high cycle life, Porocel charge in the West Tulsa unit has been in use for an extended period of time, and cumulative life is in excess of 150 barrels of throughput per pound.

Other credits include: improved tetraethyl lead susceptibility; reduced H_2SO_4 consumption; elimination of corrosion inhibitors in the recovery section.

There's always a *new place* for versatile, low-cost M & C sorptive minerals to improve the quality and cut the processing costs of petroleum products. The coupon will put us to work for *you*.

ATTAPULGUS **POROCEL PRODUCTS** *from*

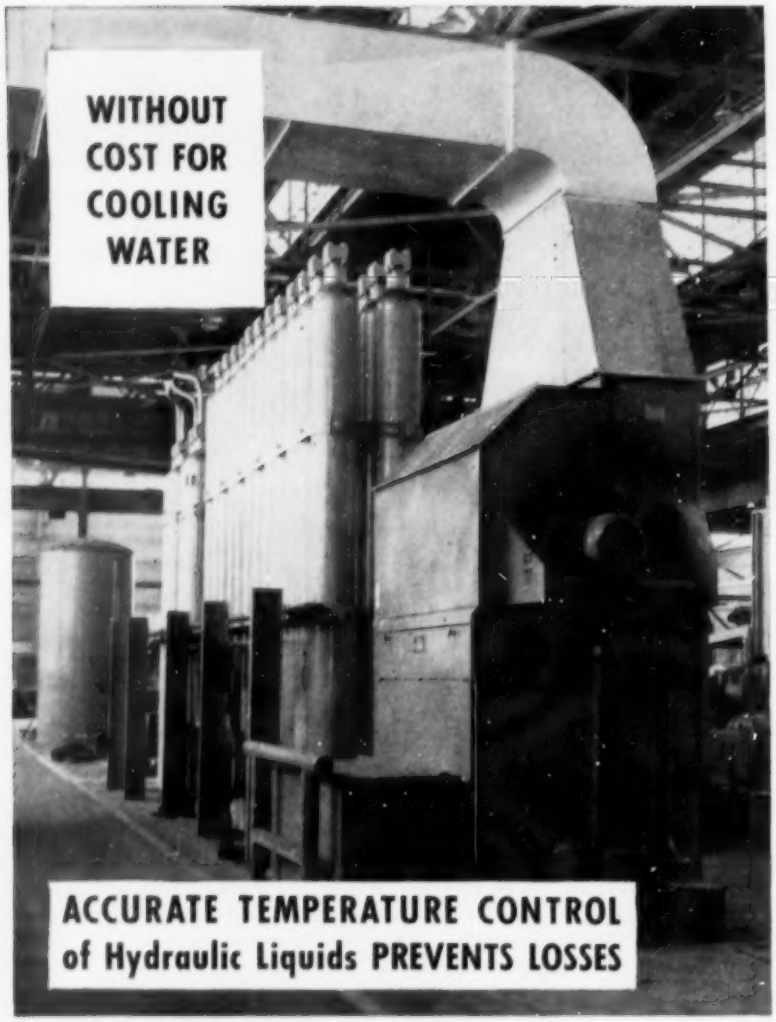
MINERALS & CHEMICALS CORPORATION OF AMERICA
15 ESSEX TURNPIKE, MENLO PARK, N. J.

ALWAYS A BETTER WAY...

MINERALS & CHEMICALS CORPORATION OF AMERICA
15 Essex Turnpike, Menlo Park, N. J.
Please send me without obligation:

- ☐ More data (with samples) on Porocel in H_2SO_4 Alkylation service
- ☐ Technical opinion on applying M & C sorptive minerals as follows

name _____ title _____
company _____
address _____
city _____ zone _____ state _____



● This NIAGARA AERO HEAT EXCHANGER cools the liquid for a large hydraulic press, preventing heat damage to the pump stuffing boxes. Using outdoor air as the evaporative cooling medium, it removes the heat at the rate of input (1,875,000 BTU/hr.) with no cooling water consumption except a negligible amount evaporated.

Air is free and cheaper to move than water. You can save much expense in pumping, piping and power, and quickly recover the equipment cost from the water saving.

Similar Niagara machines cool water, oils, solutions, lubricants and coolants for many mechanical, electrical and chemical processes. You can cool quench baths, welding machines, plastic molds, furnaces, controlled atmospheres, gases, compressed air either for power or instruments or processes. In a closed system, your coolant is never contaminated. The system is simple and easy to keep up; the equipment has a long, useful life. Select from a wide range of sizes up to 30,000,000 BTU.

Write for Bulletin 120 to obtain a complete description.

NIAGARA BLOWER COMPANY

Dept. PP, 405 Lexington Ave. New York 17, N. Y.

Niagara District Engineers in Principal Cities of United States and Canada

charts list the tube, wall and cut length tolerances for hot and cold rolled carbon and stainless steel tubes. Also listed are chemical analyses and weights. The physical properties—strength, ductility, and hardness—of the tubing are set forth in details as welded, normalized, drawn and mandrel drawn. Available from Steel and Tubes Division of Republic Steel, 224 East 131st St., Cleveland 8, Ohio.

Circle No. **21** *on Reply Card*

Propeller Fans

. . . and their performance data: *Bulletin A-109B* lists sizes, speeds, and code rating for many types of propeller fans. Included are standard, utility, cool-blast, lo-noise, reversible and Bi-Pass duct fans, intake air units and unit heaters. Dimensional drawings and specifications are given for every model. Hartzell Propeller Fan Co., Piqua, Ohio.

Circle No. **22** *on Reply Card*

Leak Detector

. . . locates minute leaks of almost any size at any pressure or vacuum range. *Bulletin 483* describes the operation of this mass spectrometer that functions as a leak detector. Employing a radio-frequency principle, the detector is compact and will withstand rugged use. Beckman Division, Beckman Instruments, Inc., Fullerton, Calif.

Circle No. **23** *on Reply Card*

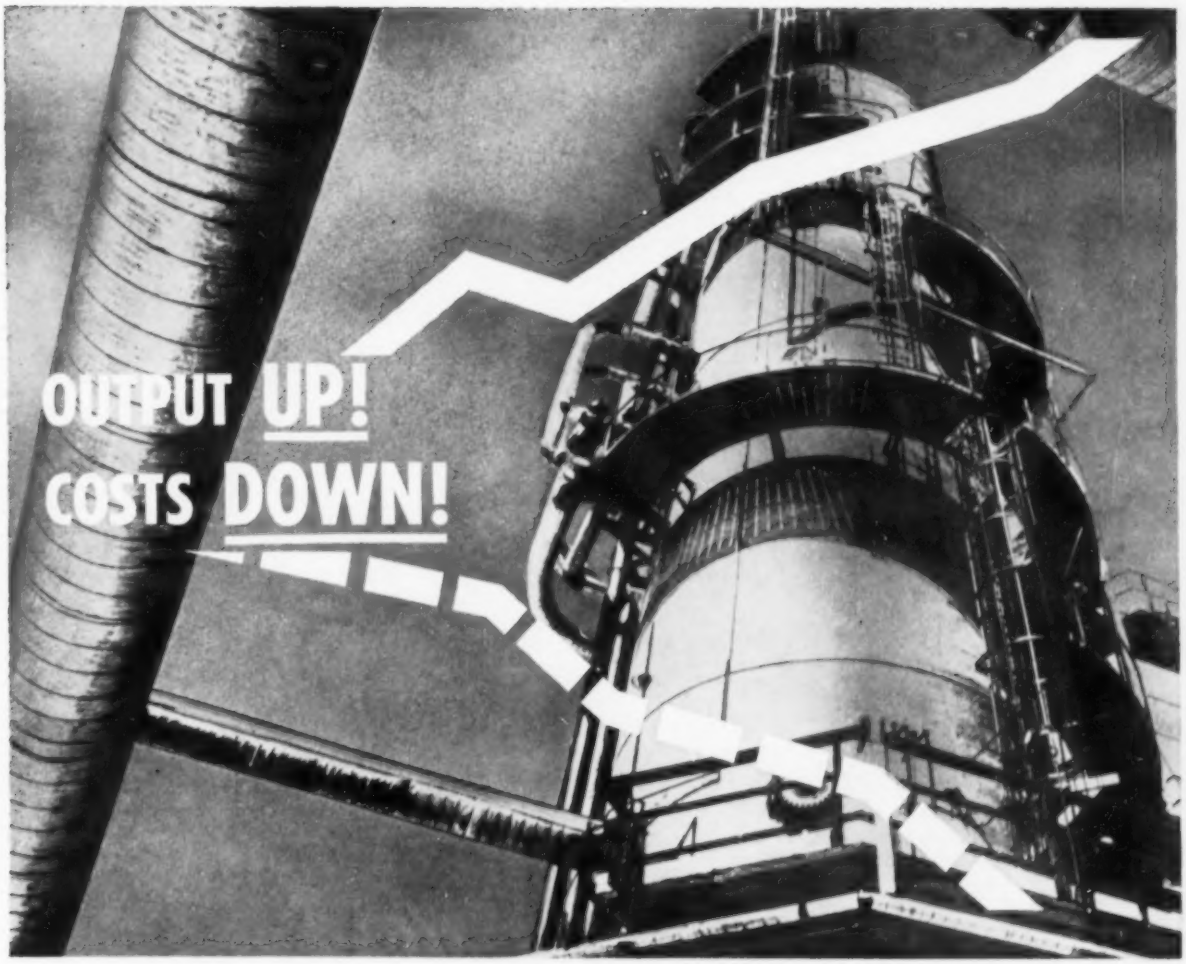
Pressure Vessel Fittings

. . . including saddles, rings, covers, yokes and bolts: *Form 456-7M-CP* includes detailed specifications for elliptical curved and flued saddles, elliptical straight rings, and standard pressed-steel handhole and manhole fittings ranging in size from 4 x 6-in. to 18 x 24-in. Materials and finish are described also. Lenape Hydraulic Pressing & Forging Co., Dept 43, Box 536, West Chester, Pa.

Circle No. **24** *on Reply Card*

Research Laboratory

. . . and its many service facilities: *Form 101 2M-6-56* is a 72-page bulletin describing in detail the test and research facilities available at the Electrical Testing Laboratories. The services of this 60-year old testing establishment include chemical, electrical, mechanical and physical, radi-



with METEX Hi-Thruput MIST ELIMINATORS

METEX Hi-Thruput Mist Eliminators, installed in process towers and vessels, effect sharp separation of liquids and gases. Quality and yield are increased. Valuable liquids are knocked out and returned. Contamination of subsequent processing is removed. Turbines and compressors are protected from damaging liquids. Where build-up of coke or solids is a consideration, on-stream service life is increased three to four times. Air pollution is reduced, too.

METEX Hi-Thruput Mist Eliminators provide virtually 100% removal efficiency, even at extreme temperatures and pressures. Pressure drop is negligible. Their outstanding performance is due to repositioning of the wires by the METEX patented Herringbone Fold . . . an exclusive development of the originators of knitted wire mesh entrainment separators. Impingement target area is increased and stagnation points reduced.

In any processing equipment or vessels where liquid entrainment is a contributing factor in design or operation, specify METEX Hi-Thruput Mist Eliminators to assure greater production, improved quality of yield and substantially reduced operating and maintenance costs.

For complete information and specifications, write today for your free copy of Bulletin No. ME-6.

6-201

METAL TEXTILE CORPORATION ROSELLE, NEW JERSEY

Metal Textile Corp. of Canada, Ltd., Hamilton, Ontario • Representatives in principal cities throughout the world

 (To obtain more data on advertised products see page 208)

More than a mere pipe fitting!

catawissa
PERFECT SEAL
unions

give a 3 to 1 safety factor
PLUS
A PERFECT SEAL!

THERE'S A CATAWISSA PERFECT SEAL UNION FOR EVERY USE . . . ALL TEMPERATURES, ALL PRESSURES!

The full dependability of HOT FORGED STEEL is yours in a Catawissa Union (hot forged from solid steel bars) with several extra value features that are exclusive here at the UNION SPECIALISTS!

All Catawissa Unions are designed to give a 3-to-1 SAFETY FACTOR . . . 3,000-lb. service unions are tested to 9,000-lbs., 6,000-lb. service unions tested to 18,000-lbs., etc.

Exclusive Ball-to-Angle seat design assures a PERFECT SEAL even when the pipe is not in alignment!

Machining operations assure a UNIFORMITY AND ACCURACY heretofore found only in special fittings and, with rigid inspection both during and after machining, guarantees LEAKPROOF CONSTRUCTION!

Satisfaction is guaranteed in any application—whether it be general low pressure service or extremely high pressures and temperatures (for air, oil, gas, chemicals, hot oils, gases or steam).

WRITE FOR CATALOG 56

AVAILABLE FROM LEADING INDUSTRIAL SUPPLY FIRMS

CATAWISSA VALVE & FITTINGS COMPANY
150 MILL ST ★ CATAWISSA, PENNA.

ometry, photometry and electronic departments. Pictures and tabulations detail the facilities of each department. Electrical Testing Laboratories, Inc., 2 East End Ave., New York 21, N. Y.

Circle No. **25** *on Reply Card*

"Tubeseal" Floating Roof

. . . its design and construction: *Catalog-TS-56* illustrates with drawings and pictures this patented method of sealing the rim of floating roof tanks. One section of the 8-page catalog features a question-and-answer discussion on the design, materials, applications and operating problems of this new type seal. Hammond Iron Works, 630 Fifth Ave., New York 20, N. Y.

Circle No. **26** *on Reply Card*

Forged Steel Fittings

. . . are cataloged in 28-pages: *Bulletin A-3-56* contains complete dimensional, engineering and application data on forged screw-end and socket-welding fittings designed for high pressure service. Data is organized into simplified charts for easy reference. The engineering data section contains information on materials selection, pressure ratings, pipe thread and socket-welding specifications, as well as useful hydraulic and mathematical tables. W-S Fittings Division, H. K. Porter Co., Inc., P.O. Box 95, Roselle, N. J.

Circle No. **27** *on Reply Card*

Sludge Removal

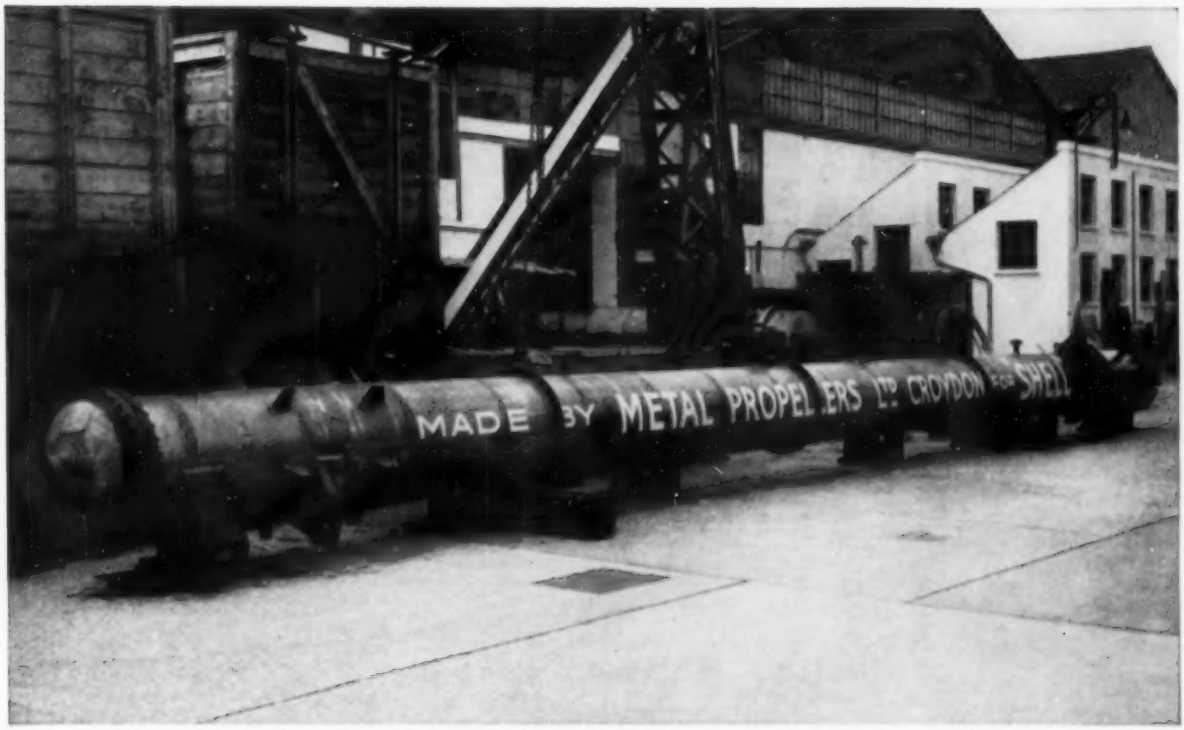
. . . by air flotation equipment: *Design Data* booklet includes a 20-page catalog on the Gibs flotation unit plus a set of twelve drawings detailing available models. A schematic flow diagram and text carefully explains the operation of a flotation unit for removing surface sludge under many conditions. Specifications for standard units are listed in detail. F. S. Gibbs, Inc., 2300 Washington St., Newton Lower Falls 62, Mass.

Circle No. **28** *on Reply Card*

Plastic Products

. . . made from trifluorochlorethylene are characterized by extreme chemical inertness, thermal stability, high impact and compressive strength, low cold flow, dimensional stability, zero

(To obtain more data on advertised products see page 208)



New tower goes to English plant. Light, efficient, all-Monel nickel-copper alloy "Turbogrid" design reduces both construction and operating costs of this mesityl oxide unit designed by Shell Development Company.

New, all-Monel mesityl oxide tower points way to lower fractionating costs

Shell—*designed Turbogrid unit is expected to operate at high capacity with low maintenance.*

Things are popping in bubble tower design.

Take this all-Monel® nickel-copper alloy distillation tower. When all facts are in, it may prove the forerunner of all-Monel alloy construction for units where only carbon steel is used today. With this type of alloy construction, longer tower and tray life, lower maintenance, and greater operational versatility can be expected.

The column (shown here on its way to the Stanlow Refinery of Shell Refining and Marketing Company in Cheshire, England) separates mesityl oxide from hot, acid-treated diacetone alcohol. It is 55 feet high, fitted with 40 Shell Turbogrid trays . . . stamped from Monel alloy plate.

Slotted grids provide highly efficient vapor-liquid interchange. There are no dead zones. Pressure drop per tray is low and very high throughput is obtained. Fouling is slow. Cleaning easy.

The Monel alloy trays are amazingly light: because of simple construction (which results in low liquid hold-up) . . . and because the strength and corrosion resistance of the alloy permit thin gauges.

The result? Much lighter, less costly structure, and lower fabrication and construction costs.

In this instance the anticipated cost differentials justified Monel nickel-copper alloy for tower shell as well as trays. It is expected that actual operation will reveal additional savings. This would extend the use of this alloy to many refining and petrochemical fractionators where corrosion has been an accepted trouble in the past.

If you face this situation and would like to discuss the possibilities with one of Inco's Development and Research engineers, contact . . .

®Registered Trademark

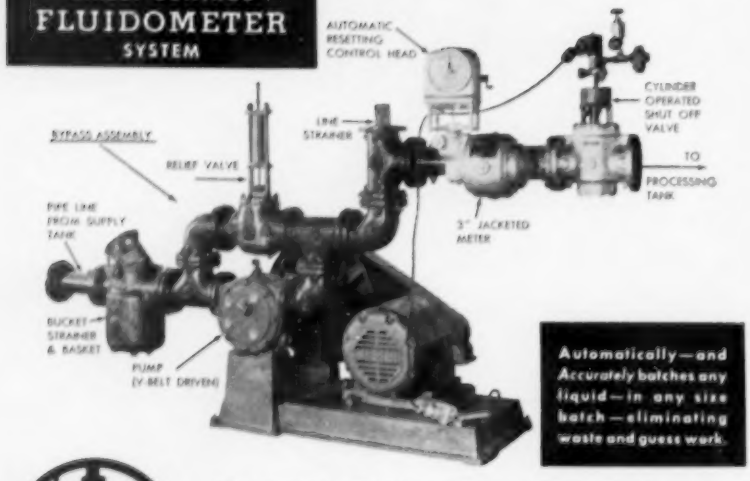
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO Nickel Alloys

Monel . . . *for minimum maintenance*

 (To obtain more data on advertised products see page 208)

TYPICAL ALL-JACKETED DIRECT CONTROL FLUIDOMETER SYSTEM



Automatically—and Accurately batches any liquid—in any size batch—eliminating waste and guess work.

H&B ESTABLISHED 1907

This typical all-jacketed direct control Fluidometer System shows how the flow of liquid is controlled from supply tank to processing tank. In this installation the three units of the Fluidometer System (automatic resetting control head, meter and control valve) are assembled in one closely related grouping. These units may be placed remotely at some distance apart if plant arrangement or convenience so suggest. The FLUIDOMETER resets itself—*automatically*—eliminating the human element, with its possibility of error, and insuring accuracy to within a small fraction of 1% in any type of service. Write for new Bulletin FI-56. For information on jacketed pipe and fittings write for Bulletin J-56.

HETHERINGTON & BERNER INC. · ENGINEERS-MANUFACTURERS
715 KENTUCKY AVENUE INDIANAPOLIS 7, INDIANA

BOWSER

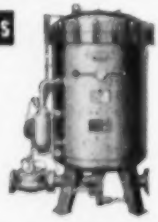
SYSTEMS SPEED PROCESSING TO CUT PRODUCT COST

METERS FILTERS

Metering and filtering of liquids from bulk receipts through delivery assure quantity and quality control.

BLENDERS DEHYDRATORS

Closed system proportioning and blending of liquid stocks plus continuous dewatering where needed, deliver a better end-product at lower cost.



Write for Catalogs

All equipment available on lease or purchase payment program . . .

BOWSER PROGRESSIVE PURCHASE PLAN

BOWSER NATIONWIDE SALES AND SERVICE

REGIONAL OFFICES: ATLANTA · BOSTON CHICAGO · CLEVELAND · DALLAS · KANSAS CITY LOS ANGELES · NEW YORK

BOWSER, INC., 1329 E. Creighton, Fort Wayne, Ind.

moisture absorption and high dielectric strength. Brochure titled *KEL-F Fluorocarbon Products* details the types and grades of each form of this plastic that is used in lubricants, in molded pipe and fittings, as a packaging material and as a corrosion-resistant coating. M. W. Kellogg Co., Chemical Manufacturing Division, P. O. Box 469, Jersey City 3, N. J.
Circle No. **29** *on Reply Card*

Koroseal Pipe

. . . is unaffected by most alkalies and acids and can be assembled with conventional tools. *Catalog 10050* describes the special properties of this rigid pipe, gives instruction on how to install it, and tabulates the conditions under which the two types of pipe—high impact or normal impact—will resist attack from 130 different chemicals. The B. F. Goodrich Co., Plastic Products, Marietta, Ohio.
Circle No. **30** *on Reply Card*

Monomers

. . . their properties and suggested uses: *Bulletin F-40033* lists 36 monomers which are available for making synthetic rubbers, oil additives, latex paints and other applications. In tabular form are listed the formulas, specific gravities, and boiling points for these products manufactured by Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.
Circle No. **31** *on Reply Card*

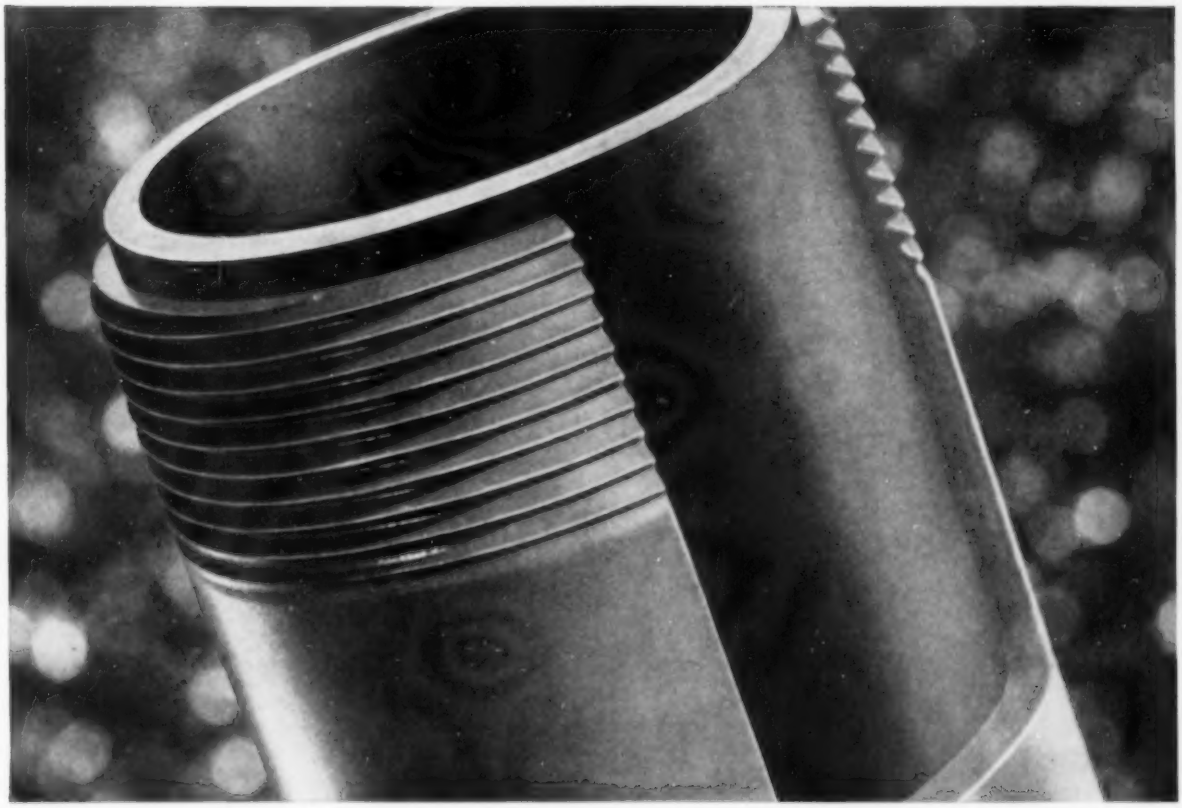
Heating Cable

. . . permits consistent temperatures of 275°F by using silicone rubber insulation: *Bulletin L-1138* describes the characteristics of Chromolox Hi-Temp Thermwire, a high quality nichrome resistor wire which can be wrapped around tanks, valves, pipelines. Temperature control can be automatic, and the heat output is selected by choice of wire length. Tables are provided to aid in the selection of the right length for different applications. This bulletin also includes installation instructions. Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.
Circle No. **32** *on Reply Card*

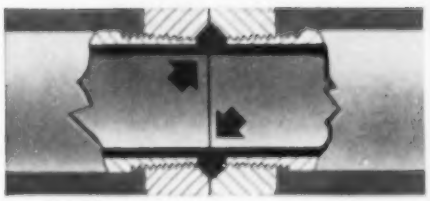
High Vacuum Distillation

. . . for separation of materials with molecular weights above 250: *Rota-Film Still* is a 14-page brochure de-

DOW



You can see why Saran Lined Pipe cuts corrosion costs



Liquid never touches metal in saran lined pipe even at a flanged connection like this.

It's made of corrosion-resistant saran swaged into rigid non-bursting steel . . . liquid never touches metal in these installations

Here's your best way to convey acids, alkalies and other corrosive liquids—saran lined pipe, fittings and valves. This modern piping is corrosion resistant . . . forms snug, leakproof joints . . . is available for working pressures up to 150 psi. Fittings and valves are also available in steel for working pressures to 300 psi.

Installation costs are low with saran lined pipe, fittings and valves. Saran lined pipe can be cut and threaded in the field with available pipe-fitters' tools. Its rigidity means few supporting structures are needed.

Saran lined pipe has an outstanding record of trouble-free performance in the chemical, petroleum, waste, pulp and paper, metal finishing, and food processing industries. For further information send in the coupon at the right. THE DOW CHEMICAL COMPANY, Midland, Michigan.

Saran Lined Pipe is Manufactured by The Dow Chemical Company, Midland, Michigan

Saran Lined Pipe Company
2415 Burdette Avenue
Ferndale 20, Michigan
Dept. SP625F-1

Please send me information on saran lined pipe, valves and fittings.

Name _____ Title _____

Company _____

Address _____

City _____ State _____

you can depend on DOW PLASTICS

DOW

 (To obtain more data on advertised products see page 208)

Here's How to Get

MORE WORK from Steam Equipment!

● Bring your steam-using production units up to maximum work capacity in one-eighth the time it now takes. Add a full production cycle per day to kettles, autoclaves, dryers, heaters, etc! Equip all production units with the Heat-Kwik Super-Silvertop steam traps. A new combination open float and thermostatic design enables these traps to purge all air from cold units at once so that unvented air cannot mix with steam entering steam compartment, thereby reducing the temperature and acting as heat insulator. Get more production. Install Heat-Kwiks. See your jobber or mail coupon for further information.

THE NEW WAY
Notice the simplicity and saving in fittings.

THE OLD WAY
Notice how bottom inlet requires complicated piping.

FREE HEAT-KWIK BULLETIN!
Bulletin 1153 contains prices, capacities and specifications on Heat-Kwiks. For your copy fill out and mail to:
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Division of International Basic Economy Corporation
1935 West 96th St. • Cleveland 2, Ohio

Name _____
Company _____
Address _____
City _____ State _____

ANDERSON
SUPER-SILVERTOP STEAM TRAPS
The Engineered Steam Traps

scribing the construction features and the special applications of this special type of distilling equipment. It permits commercial processing of higher molecular weight and heat sensitive materials without losses due to side reactions, such as polymerization and cracking. Included in the brochure are pictures of typical installations, cross-sections of this still, flow diagram of a typical installation, and a vapor pressure chart for many common low vapor pressure materials. Arthur F. Smith Co., Rochester 3, N. Y.

Circle No. **33** *on Reply Card*

Unusual Flowmeter

. . . measures and totalizes the mass rate of flow by measuring the rate of heat transfer through the boundary layer of fluid. *Electro-Caloric Flowmeter* is a bulletin describing the meter which handles almost any type of liquid or gas, including corrosive substances, pulsating flows and slurries. The flow cell measuring elements are sealed from both the fluid stream and the surroundings, and transmit an electric signal by cable to the reading meter. Industrial Development Laboratories, Inc., 17 Pollock Ave., Jersey City 5, N. J.

Circle No. **34** *on Reply Card*

V-Drive Sheaves

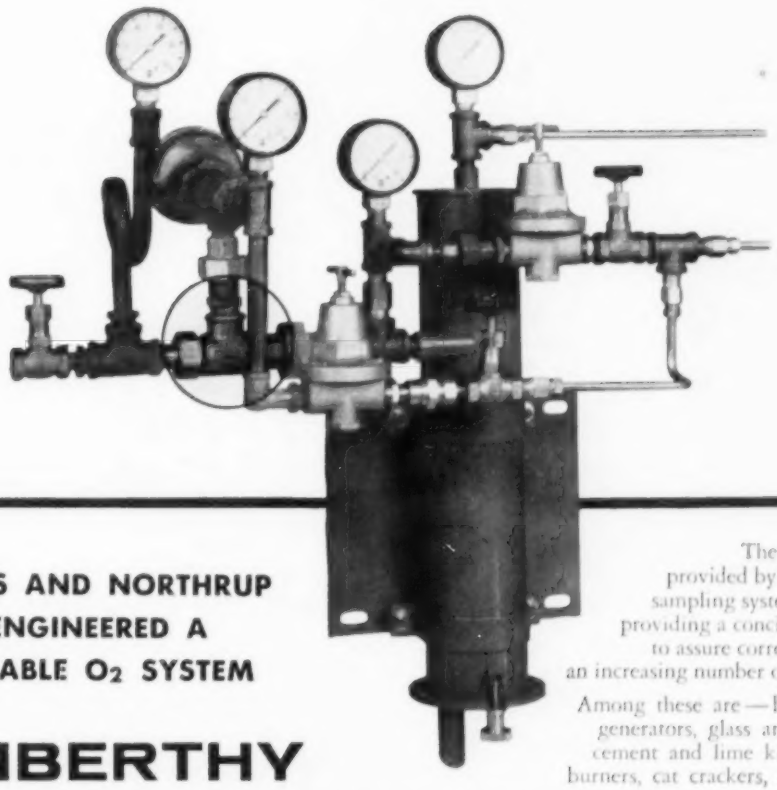
. . . all kinds, both standard and custom-made, are featured in *Catalog MVD-56*. This 18-page bulletin offers practical information on the handling of sheaves as well as details on dimensions and construction. Tables and charts give full data on sheaves dimensions for "A" section, combination "A" and "B" section, "C" and "D" section sheaves. Also included is data on bushings required for these sections. Maurey Manufacturing Corp., 2915 South Wabash Ave., Chicago 16, Ill.

Circle No. **35** *on Reply Card*

Mixing Liquids

. . . or liquids and gases: *Addendum No. 1, Technical Supplement HM* discusses the general theory of mixing, classes of fluids and viscosities, continuous vs. batch mixing and the advantages of continuous mixing. Featured is information on "Homomix," a continuous pipeline mixer available in sizes up to 15,000 gph. The 14-page supplement includes

TO STOP DOLLARS *from* GOING UP THE FLUE...

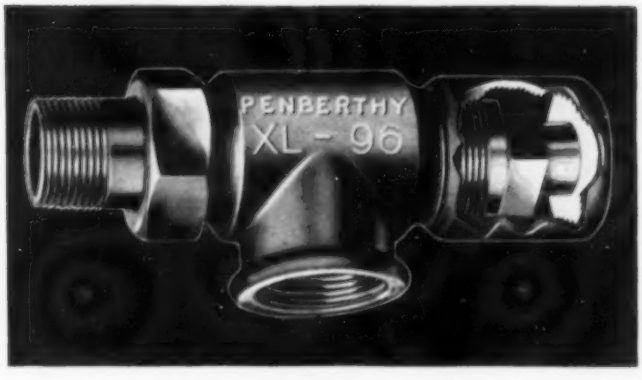


LEEDS AND NORTHRUP ENGINEERED A RELIABLE O_2 SYSTEM

The high-speed flue gas sample provided by L & N's new steam-operated sampling system is instrumental in providing a concise and reliable O_2 picture to assure correct combustion conditions in an increasing number of industrial applications.

Among these are—boilers, atmosphere generators, glass and open hearth furnaces, cement and lime kilns, hydroformers, SO_2 burners, cat crackers, and fluid coke units.

PENBERTHY PROVIDED A POWERFUL PUMP *in a small package*



In moving stack gas to the analyzer . . . the Penberthy Ejector offers practical advantages over mechanical pumps. Smaller, more compact and less costly, it is assembled as an integral part of L & N's equipment. It is not subject to mechanical failure (no moving parts) and has high corrosion resistance.

LOCAL JOBBER SUPPLIED INITIAL UNITS

Like L & N, you, too, will find that leading supply companies carry a complete line of standard Penberthy Ejectors suitable for most pumping applications. For special jobs or detailed technical information, write direct.

PENBERTHY MANUFACTURING CO.

Division of Buffalo-Eclipse Corporation

1242 Holden Avenue Detroit 2, Michigan

There's Certain Satisfaction in **PRODUCTS BY** PENBERTHY

- GAGES
- EJECTORS
- EDUCTORS
- EXHAUSTERS
- SYPHONS
- ELECTRIC SUMP PUMPS
- CYCLING JET PUMPS
- INJECTORS

THE JOB:

TUBE SHEET REPAIRS

IN HIGH PRESSURE HEATER

The 3½" thick tube sheet was leaking badly. Our job was to remove old weld by drilling and burning, uncover and pierce 44 tube ends below tube sheet, apply 44 tapered steel plugs and replace weld. A previous unsuccessful repair attempt (not by CONSECO) had cost the client $18,000.

In 8½ working days, at a cost of only $4,000 three CONSECO men completed the work. Hydrostatic tests, using fluorescent dyes and black lights, plus circulating tests of 2500 lbs. of hot water pressure, proved everything satisfactory.

And our client saved the cost and delay of retubing, estimated at $25,000. *This shows what can be done by CONSECO SERVICE on any tubular equipment. Available anywhere . . . 24 hours a day, 7 days a week, Sundays, all holidays. 'Phone Maintenance Department.*

• *Send for Bulletins giving complete engineering data on these products.*

EQUIPMENT DESIGNED AND BUILT BY CONSECO

HEAT EXCHANGERS • CONDENSERS • EVAPORATORS • STEAM JET AIR EJECTORS • STEAM GENERATORS • PRESSURE VESSELS CENTRIFUGES • FILTERS and STRAINERS • PUMPS, INSTRUMENTS, SPECIALTIES

12

CONDENSER SERVICE & ENGINEERING CO., INC.

Designers and Builders of Equipment for Power, Refining, Chemical and Marine Industries

54 BLOOMFIELD STREET
HOBOKEN, N. J.

curves on size and capacity of this pipeline mixer, typical applications and design specifications. The American Well Works, Aurora, Ill.

Circle No. **36** *on Reply Card*

Tube Tools

. . . including cleaners, expanders and cutters: *Bulletin No. 58* describes those used for maintenance, and *Bulletin 59* describes the tube cutters. A brief description of each tool plus a listing of sizes available is included. Airetool Manufacturing Co., Springfield, Ohio.

Circle No. **37** *on Reply Card*

Distillation Apparatus

. . . for the "do-it-yourself": *Bulletin FS-256* describes the unitized fractional distillation apparatus now available for meeting most lab needs. The building blocks include columns, still heads, still pots, receivers and all the accessories required for setting up a special distillation assembly from stock parts. The apparatus performs routine distillations anywhere in the 50 to 250°C range at atmospheric pressure, and to above 350°C under reduced pressure. Fisher Scientific, 717 Forbes St., Pittsburgh 19, Pa.

Circle No. **38** *on Reply Card*

Dust Collector Bulletin

. . . describes the operation and construcion of a multiple tube, centrifugal collector tradenamed "Cyclo-trell". *Bulletin 100* lists the design features which boost collection efficiency and gas handling capacity of this equipment, which separates gas and particles by centrifugal force. Included in the bulletin are nomographs for determining collection efficiency and the capacity and total number of tubes required in specifying the collector desired. Detail dimensions of various models are given for space determination. Research-Cottrell, Inc., 405 Lexington Ave., New York 17, N. Y.

Circle No. **39** *on Reply Card*

Plastisol Coating

. . . that can be sprayed in a single application to a thickness of 60 mils: *Bulletin SP-1* describes how this vinyl coating, resistant to corrosion, can be applied to even vertical surfaces to give a tough, rubberlike coating. The heavy film thickness avoids pinholes and thin spots that may permit chemi-

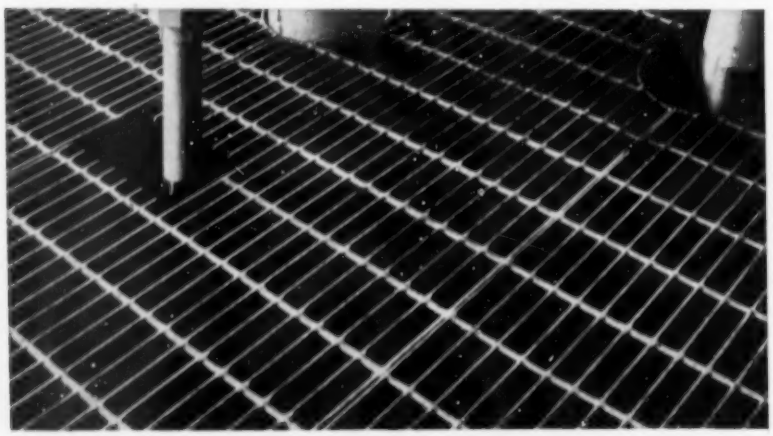
You and I both belong here! After all, there wouldn't *be* any busy highways without us! I'm a secretary to a land man. You may be anything from a driller to a board chairman. Between us we helped keep over 50 million cars on the road last year. People used them for fun, convenience, business. Remember that, the next time you hear unfair criticism of us oilmen. We've got lots of facts on our side. Let's speak up and make the facts known! **SHELL OIL COMPANY**

LITHIUM METAL AND ALLOYS
LITHIUM HYDRIDE
LITHIUM HYDROXIDE
LITHIUM CARBONATE
LITHIUM CHLORIDE—BRINE—ETC.

LITHIUM
MAYWOOD

Pioneers in Lithium since 1901

MAYWOOD CHEMICAL WORKS
MAYWOOD, NEW JERSEY
ESTABLISHED 1895



Gary WELDED GRATING
Tailor Made to Your Specs

Save installation time and money by having Gary factory-fabricate your open steel flooring needs. For complete description of Gary Gratings, write for Catalog No. PP-96

FREE SAMPLE
We'll send this handy paper weight if you request it on your company stationery.

Standard Steel Spring Division
ROCKWELL SPRING AND AXLE CO.
4016 East Seventh Avenue • Gary, Indiana

cal breakthroughs, and also offers greater resilience to impact. Instructions for applying this plastisol are included in this bulletin. Metal & Thermit Corp., Rahway, N. J.

Circle No. **40** *on Reply Card*

Did You Miss These?

The following items, reviewed originally in May, have aroused considerable interest among readers. They are repeated here briefly as a service to those who might have missed them the first time they appeared. For details or literature, please use the regular Reply Card in this issue.

Heat Transfer

. . . building blocks: *Catalog HT-23* is a reference guide on the use of National Sections used to build cooling and condensing systems for process fluids. Included are data on their use in refineries and gas plants, and their physical characteristics for design purposes. One section of the catalog deals with thermal design, presenting the solution to a typical process problem. National-U.S. Radiator Corp., 342 Madison Ave., New York 17, N. Y.

Circle No. **41** *on Reply Card*

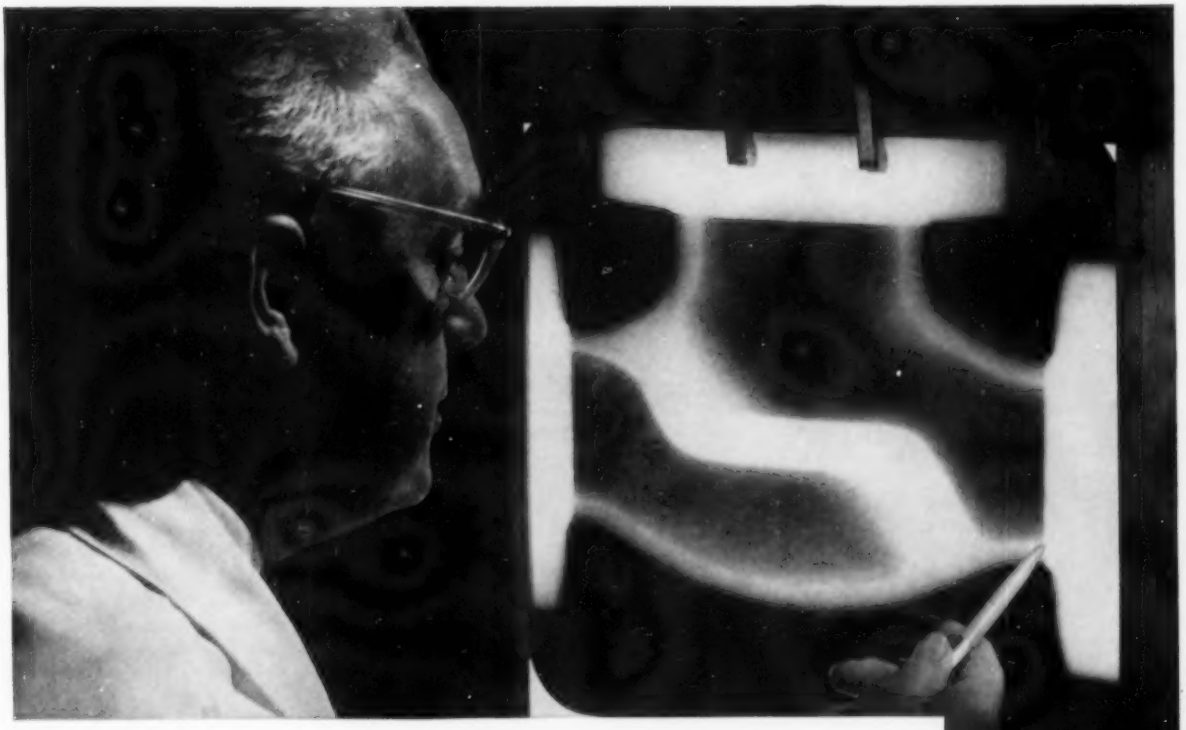
Vessel Fabrication

. . . techniques: *Catalog No. 554* tells in 48 pages the story of custom fabrication of tanks and pressure vessels. Useful for reference purposes is that part of the catalog that lists the corrosive action of 200 different chemicals (in various concentrations) on 16 different metals. These data have been developed with the aid of research laboratories of the largest metal producing companies. Nooter Corp., 1400 S. Second St., St. Louis, Mo.

Circle No. **42** *on Reply Card*

Abrasive Material Pump

. . . handles petroleum coke, using a clear water seal to protect the rotating parts of the pump. Designed to handle ash, slag and fly ash, as well as coke, the pump permits a small stream of water to flow continuously through the clearance spaces between the rotating impeller and the stationary parts of the shell. This water seal protects the shaft, stuffing box and suction seal from the abrasive particles. It also prevents recirculation of the solid-



Inside story:

Valves may look alike on the surface. Their performance is another story. And the inside story of Powell Valves is that *every* Powell Valve has *Performance Verified.*

X-ray and gamma ray inspection—examining the very structure of the metal itself—are two of the many ways that Powell can make absolutely certain that Powell Valves will give *dependable* flow control.

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FIG. 1503—150-Pound Steel Gate Valve.

FIG. 6003—Steel Gate Valve for 600 Pounds W.S.P.

FIG. 6061—600-Pound Steel Swing Check Valve.

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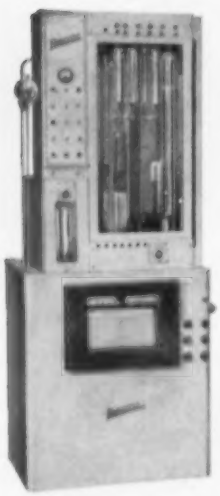

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Circle No. **43** *on Reply Card*

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The absence of any flying abrasives provides safety to adjacent workers and equipment. Should the operator's grip slip a "deadman's" control stops the unit. The abrasives that can be used include: malleable shot and grit, aluminum oxide, walnut shells, and steel grit. It is operated by compressed air and consumes 33 to 60 cmf. The recommended operating pressure is 90 to 100 psi. Clementina Ltd., 2277 Jerrold Ave., San Francisco 24, Calif.

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Easily handled, the rope can be used for insulator wrapping, high temperature gaskets and seals, and as a high temperature joint packing. It is supplied in coils with a maximum length of 800 ft. Carborundum Co., Niagara Falls, N. Y.

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THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

What Caused It?

WHY is the United States confronted with a serious shortage of scientists and engineers?

One reason, discussed in earlier editorials in this series, is that the increasingly complex technology needed for national security and for an expanding economy has raised enormously the demand for technically trained people.

But it is clear also that too little has been done to increase the supply of scientists and engineers and to make most effective use of the limited number now available. It is with this second reason for the shortage that this editorial deals.

Too few bright young people have been attracted to careers in the sciences and engineering. Many with technical training have been leaving these professions, with the exodus from teaching being especially alarming. And the technical talent now employed in industry, government and education is, in too many instances, being utilized less effectively than it might be.

Paying for a Miscalculation

A legacy of the depression provides part of the explanation for the current shortage of young people entering scientific and engineering careers. Because of low birthrates in the 1930s, there are now about one million fewer boys and girls of college age than there were in the early 1940s. Not until 1960 will there be as many in the 18-21 age group as in 1945. And from the brightest young people of these ages must come, not only scientists and engineers, but the new members of all the professions needed by our growing economy.

A miscalculation in the late 1940s, when our future needs in various occupations were being gauged, provides another part of the explanation. Occupational counselors and high school students were advised that, because of heavy postwar enrollments in engineering and other technical fields, "it is likely that the shortages of trained men will be alleviated in a few years."*

Instead of being alleviated, however, the shortages became more acute. Job opportunities grew rapidly, while graduating classes dwindled. Fewer than half as many students received degrees in engineering in 1955 as in 1950, the peak postwar year. The trend has been reversed, but graduating classes will not be large enough to narrow the gap for several years.

Lost Talent

Beyond these temporary conditions, there is another explanation for the failure of the number of scientists and engineers to keep pace with our rising needs. This is the staggering loss between high school and college of young people with the talent to be successful in science and engineering. **Last year between 60,000 and 100,000 high school graduates of college ability failed to enroll in college for financial reasons and perhaps an additional 100,000 did not enter college because of lack of interest.†**

Of the most intelligent 20 percent in the group of college age, fewer than half enter college and only about a third graduate from college. Educational authorities estimate that fewer than 2 percent of those in the college age group who are mentally equipped to obtain Ph. D. degrees will actually obtain such degrees.

Another crucial stage is in the high

*U. S. Bureau of Labor Statistics, *Occupational Outlook Handbook* (Bulletin 940), p. 63.

†Charles C. Cole, Jr. (assistant dean, Columbia College, Columbia University), *Higher Education*, November 1955.

schools, where future scientists and engineers receive their first training in science and mathematics. There are serious weaknesses and signs of deterioration in this vital part of our educational system.

One-quarter of all American high schools offer no chemistry or physics. One-quarter offer no geometry. In many of the schools offering science and mathematics courses, the quality of instruction is low. Last year in the New York City school system alone more than 10,000 students were in science classes taught by teachers who were not trained in science.

This is a situation that threatens to become much worse. Between 1950 and 1955 the number of graduating teachers qualified to teach high school mathematics dropped 53 percent and those qualified to teach science dropped 59 percent. Furthermore, only about 60 percent of the graduates certified to teach mathematics or science in 1955 entered teaching as a career.

On the students' side — partly because of inadequate guidance programs — there has been a drift away from science and mathematics courses. The result of low student interest, and poor high school programs, in science and mathematics is virtually to foreclose careers in science and engineering to many bright young people. They miss the necessary basic training. Many who do attempt to obtain college training in these fields are ill-equipped. Engineering school deans report that fully half of their students enter with deficiencies in mathematics.

Misuse of Trained People

Scientific and engineering careers have long had a reputation for low salaries and limited opportunities for advancement. In recent years starting salaries have sky-rocketed and have been accorded wide publicity. But unfortunately there has been much less improvement in the salaries paid experienced engineers and scientists, especially in government and education. This has lowered the morale of experienced men and provided an incentive to desert engineering and research positions for higher paying jobs in sales or management.

Engineers and research scientists complain also that too much of their time now is spent on tasks that draftsmen and technicians could perform. Unfortunately for easy solution of this problem, however, there is an acute shortage of technicians as well. Worse still, there are indications that some companies in industries using large numbers of engineers have gobbled up technical manpower at a faster rate than they can effectively employ these scarce people.

Another drain on the supply of newly-trained scientists and engineers is military service. About 8,000 of this year's 27,000 engineering graduates were in ROTC programs and committed to active duty after graduation. Dr. A. W. Davison, chairman of the Engineering Manpower Commission of the Engineers Joint Council, says that in most cases no attempt is made by the Armed Services to assign these young officers to duties for which their engineering education specifically prepared them. They are not only withheld from industry and education for two years but also are not utilized in defense programs requiring more engineers and research scientists.

Some of the causes for the present shortage of scientists and engineers — bad advice a few years ago and a college age group held down by depression birthrates in the 1930s — are gradually being overcome. But others, such as the deterioration of science and mathematics training in our public schools and the many instances of ineffective utilization of scarce technical talent, enjoy no such prospect of automatic correction. The final editorial in this series will deal with some practical suggestions for meeting these problems.

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EDITORIALS . . .

Should UOP Be Sold?

SEVERAL questions of broad importance to the petroleum industry are raised by the recent request of Guaranty Trust Co. for permission to sell all or part of Universal Oil Products Co.

To give you a little background, in 1944 the six major oil companies which then owned UOP decided the company was a losing proposition for them (particularly in view of the threat of anti-trust actions). So they set up a trust known as the Petroleum Research Fund and donated the securities of UOP to it. Guaranty Trust Co. was named trustee to hold the securities for the Fund, with profits from UOP's operations to go to the American Chemical Society for financing research in the petroleum and natural gas field.

Under the terms of the trust agreement, UOP is obligated to continue its research and development activities—which it has done with notable success. To its credit since the Fund was set up are such process developments as Platforming, Rexforming, Udex and Penex, plus many improvements in existing processes.

Last June, Guaranty Trust filed a petition in New York State's Supreme Court asking permission to sell any or all of the UOP securities it holds for the Petroleum Research Fund. Reason given was that it felt the Fund would realize a larger and more stable income if it had a more diversified investment. ACS, as administrator of the research program financed by the Fund, agreed with the application.

Perhaps it should be pointed out here that since the Fund was set up in 1944, ACS has collected over $1.5-million from it. According to the last published financial statement of ACS, the Fund as of Jan. 1, 1956 had a balance in it of $1,271,451.23—nearly twice the balance in any of the 12 other "earmarked funds" that ACS controls. Income earned by the Fund last year was over $250,000—although the top amount earned by any of the other 12 funds was $36,191.03.

Objections to the proposal have been filed by the Independent Refiners Assn. of America, of which M. H. Robineau of Frontier Refining Co. is president. IRAA declares that under the trust agreement UOP's stock cannot be disposed of by the Fund until it is shown that conditions have changed since the inception of the trust so that the public welfare is no longer effectively served by restrictions against the sale. It further denies that conditions have changed under the meaning of the trust agreement, and contends there is now a greater need than ever for UOP's impartial services.

The merits of Guaranty Trust's petition and IRAA's opposition will have to be decided by the courts. As matters now stand, the New York Supreme Court has referred Guaranty's application to William J. O'Shea, an attorney of 20 Exchange Place, New York City. He will serve as referee to hear the issues involved.

If the petition is granted, we have no doubt that the sale of UOP could result in policy changes in the firm's operations that would adversely affect the many small independent refiners in this country. These refiners are in no position to carry on the research and development work necessary to stay abreast of current technical developments. They lean heavily on UOP's research and technical services—and because of the availability of these services at reasonable fees many of these refiners who otherwise might have had to close down have been able to stay in business.

As Mr. Robineau says, UOP is "vital to the independent refining industry" in providing technological services. He fears that the independent refiner would lose those services if UOP is sold.

There's another point to remember. There are other research and development organizations as extensive as UOP's. Many of the major oil companies have larger staffs than UOP, and do more in the way of process development and improvement. But UOP has the distinction of being entirely independent. It operates horizontally across the whole industry, not just for one or a few companies. It operates for all refiners, whatever their size. As UOP itself expresses it: "We're primarily a refinery research organization. We don't compete with our customers."

Should UOP be sold, we sincerely hope that whoever buys even a part of it will realize he is acquiring not only the assets of a reputable company but also a pretty big responsibility to our petroleum industry.

We Need to Be Cautious

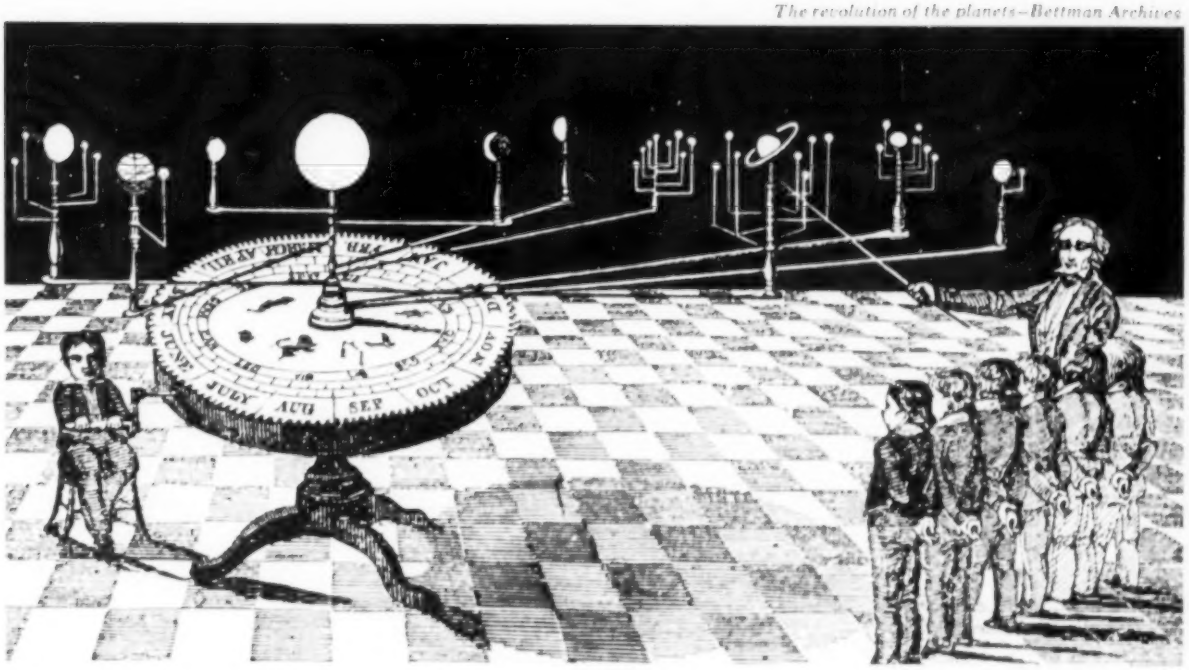
ON SUNDAY, July 29, a crew of plant and volunteer firemen was putting out a small ground fire in the tank farm of Shamrock Oil & Gas Corp.'s 20,000 b/d McKee refinery—at Sunray, Texas. (See photo p. 162).

According to reports, the ground fire appeared to be under control—but suddenly there was a brilliant flash and a deafening explosion. As a result, 19 men died.

Exactly how a minor fire grew so suddenly to disaster proportions isn't yet clear. One report blames a leaky fitting in an adjacent 15,000 bbl pentane tank. Undetected vapors from that tank could have created an explosive atmosphere in the area, which was then touched off by the "harmless" ground fire.

What we say here can do little to ease the suffering caused by the death of those firemen. But their loss should serve to remind all of us that we're usually dealing with hazardous materials in our industry. It's too easy to lose sight of that fact, and to forget the need for eternal caution.

The revolution of the planets—Bettman Archives



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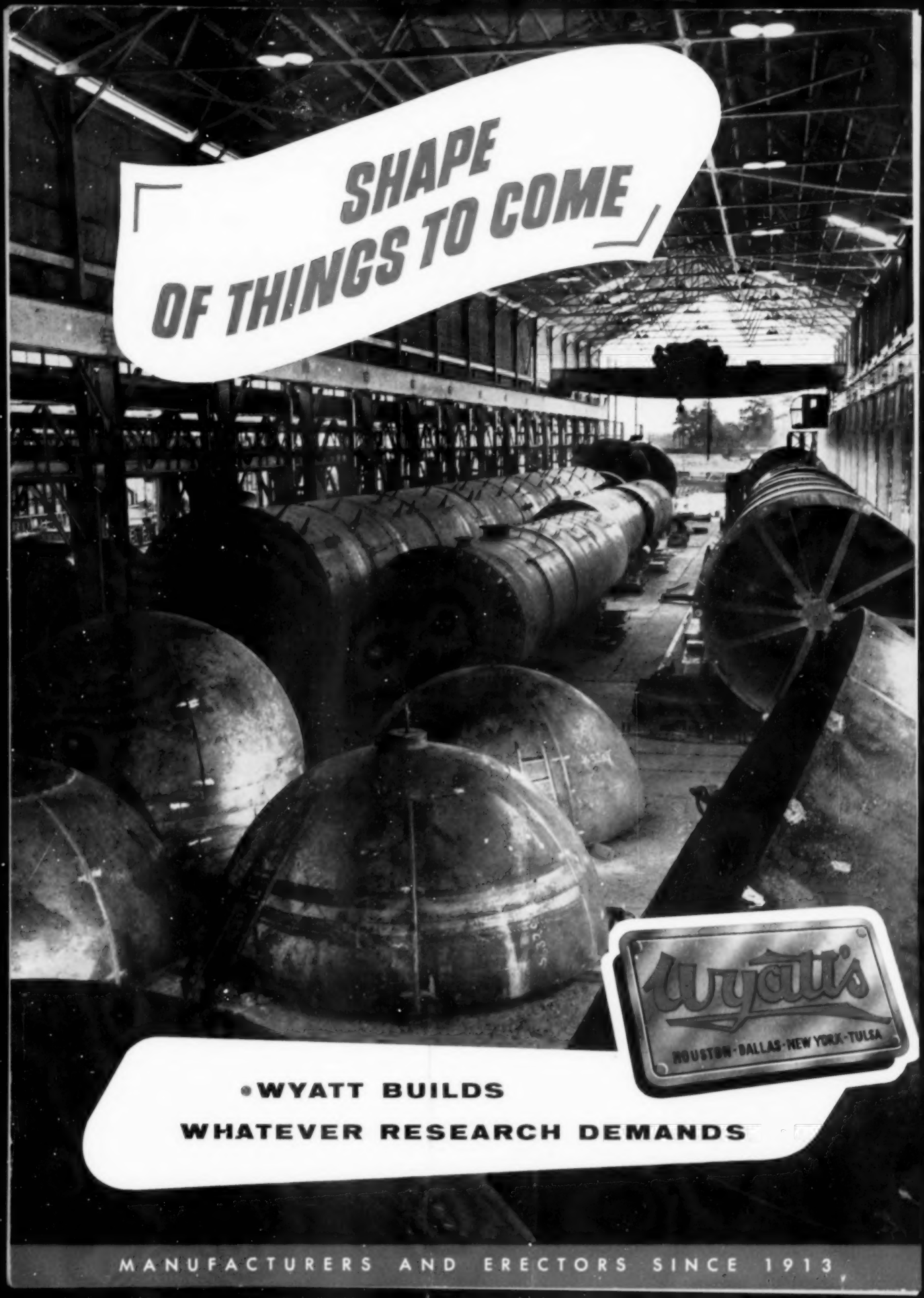
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